



436 14th Street Oakland, CA 94612
Phone: (916) 844-0134
Email: mgoebes@trcsolutions.com

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Energy Efficiency Evaluation, Measurement and Verification (EM&V) Final Report

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Submitted To:

City of Palo Alto Utilities
Attn: Dixon Yee
250 Hamilton Avenue
Palo Alto, CA 94301
(650) 329-2271
Dixon.Yee@CityofPaloAlto.org

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I EXECUTIVE SUMMARY

For the City of Palo Alto Utilities (CPAU), TRC conducted evaluation, measurement, and verification (EM&V) of CPAU's Fiscal Year (FY) 2016 energy efficiency programs. This report presents the findings of that evaluation.

TRC developed annual net and gross savings estimates of demand (kW), electric (kWh) and natural gas (therm) energy savings, as well as lifecycle electric energy savings, for the following programs:

- ◆ The Commercial and Industrial Energy Efficiency Program (CIEEP), for the two implementers that delivered projects: Enovity and Ecology Action
- ◆ Home Energy Report (HER) Program
- ◆ Small and Medium Business Program – a.k.a., EMPower Program
- ◆ Multifamily Plus program (MPP)

In addition, TRC conducted a process evaluation of the Home Efficiency Genie program.

Overall, TRC verified programs representing 6.1 GWh of ex ante savings, or 91% of the total 6.7 GWh ex ante portfolio level energy savings. For the CIEEP-Enovity and EMPower programs, TRC achieved at least 90% confidence and 6% precision for annual electricity (kWh) savings. For the MPP, TRC achieved 90% confidence and 37% precision.¹ TRC did not use sampling for CIEEP-Ecology Action or HER.² Each program chapter provides more detail on sampling methodologies and statistical rigor achieved.

I.1 Savings Summary

This section provides a summary of savings at the program and portfolio level.

I.1.1 Annual Demand (kW) and Electricity (kWh) Savings

Figure 1 shows gross annual savings for all programs, in descending order of annual kWh savings. The programs that TRC verified for FY 2016 are shown with an asterisk (*). Programs not evaluated (N.E.) do not have a realization rate, and TRC assumed (i.e., passed through) the ex ante savings.

As shown in Figure 1, the average annual kWh realization rate for the evaluated programs (weighted by ex post energy savings) was 97%. The primary energy savings adjustments included the following. As shown, some of these adjustments decreased savings, while others increased savings.

- ◆ **CIEEP**
 - **Enovity:** Adjustments to operating conditions based on trend data: TRC found that schedules or set-points assumed by the program did not match current conditions. These generally decreased savings.

¹ The high value for precision was because one project had a realization rate of over 700%; TRC assumed zero kWh savings for ceiling insulation measures, which resulted in a very low realization rate for insulation projects; and several lighting projects had significant discrepancies between ex post and ex ante savings results.

² TRC reviewed a census of projects for CIEEP-Ecology Action, and conducted the HER evaluation using savings rates based on regression analysis.

- **Ecology Action:** Baseline adjustments: For some lighting measures, TRC assumed a baseline that met federal regulations for some measures (e.g., replacements of incandescent lamps), while the program assumed existing conditions for the baseline. This decreased kWh savings. In addition, TRC adjusted calculations to include interactive effects, which increased savings. These adjustments in combination decreased savings in CIEEP-Ecology Action.
- ◆ **HER: Corrections to the savings calculation:** The ex ante savings calculation included an attribution factor that reduced savings to account for factors beyond HER that produced energy savings. However, the savings factor applied by TRC already accounted for energy savings due to non-program influences, so TRC removed this attribution factor, increasing savings. In addition, CPAU developed its ex ante savings calculation based on FY2015 residential energy use, and TRC used FY2016 energy use. Because FY2016 energy use was lower, this decreased savings.
- ◆ **EMPower: Adjustments to baseline:** TRC used baseline wattages that complied with current federal lighting regulations for several LED replacements of incandescent lamps, which reduced savings.
- ◆ **MPP: Removal of space conditioning savings:** TRC removed electric savings for ceiling insulation projects for buildings without space cooling. Additionally, TRC's saving for lighting measures (based on deemed program values) differed from the savings claimed by the implementer. However, because the program did not provide project-specific calculations for lighting measures, TRC could not identify the reasons for these differences.

The average kW realization rate for the evaluated programs was 66%. There were two major reductions in kW savings:

- ◆ **MPP lighting kW savings reductions:** The MPP claimed much higher lighting measure kW savings than TRC's calculations. The program did not provide calculations supporting its kW savings claims, so TRC cannot identify the discrepancies in assumptions between the ex ante and ex post calculations. This program had a kW realization rate of 10%.
- ◆ **CIEEP-Ecology Action kW calculation corrections:** The CIEEP program had a lower realization rate for annual kW (80%) than kWh (94%), because TRC included the coincident demand factor, while the implementer did not. In addition, the project that accounted for the majority of CIEEP-Ecology Action kW savings had a low realization rate (because they assumed an existing condition that did not comply with federal regulations implemented in 2012 to 2013).

In addition, many of the adjustments to kWh savings also resulted in similar adjustments to kW savings.

Figure 1. Gross Annual FY2016 Demand and Electricity Savings

CPAU Program	Ex Ante		Ex Post		
	Demand (kW)	Energy Savings (kWh)	Demand (kW)	Energy Savings (kWh)	Realization Rate (% kWh)
COM-CIEEP - Ecol Action*	367	2,198,872	268	1,994,193	91%
COM-CIEEP - Enovity*	60	1,968,933	74	1,932,921	98%
RES-Home Energy Report*	0	1,283,418	0	1,386,987	108%
COM-EMPower*	82	465,747	76	423,861	91%
COM-Commercial Advantage	0	418,306	0	418,306	N.E.
RES-MultiFamily Plus*	150	176,847	15	150,840	85%
RES-Smart Energy	0	81,540	0	81,540	N.E.
COM-Gen T&D	8	70,460	8	70,460	N.E.
RES-REAP Low Income	0	28,633	0	28,633	N.E.
COM-Business New Construction	0	28,556	0	28,556	N.E.
RES-Home Efficiency Genie	0	8,400	0	8,400	N.E.
Total	666	6,729,712	441	6,524,697	97%

*Programs evaluated by TRC

Figure 2 shows net annual savings. To calculate net savings, TRC multiplied the gross savings for each measure by the net-to-gross ratio (NTGR). TRC generally obtained the NTGR values for each measure from the Northern California Power Agency (NCPA) Energy Efficiency (EE) Reporting Tool based on the E3 calculator (the "NCPA E3 Calculator"), which took NTGR values from the Database of Energy Efficiency Resources (DEER) 2014. ¹This calculator provides the following assumptions for NTGR values:

- ◆ 80% for custom projects, such as CIEEP projects;
- ◆ 80% for commercial lighting measures, such as those installed in EMPower and the MPP lighting measures installed in common areas and the exterior (typically parking garage lighting);
- ◆ 100% for HER²;

¹ The one exception was for ceiling insulation installed in multifamily buildings in the MPP. TRC assumed 100% NTGR for this measure, as described in Section 8.1.

² The savings calculation that TRC followed produces net savings. Because the NTGR is unknown, TRC assumed that gross savings was the same as net savings. This underestimates gross savings, but is the most conservative method without a NTGR estimate.

- ◆ A mix of NTGRs for residential measures in MPP, including 100% for ceiling insulation, 54% for lamps installed in residential units, and 80% for lamps installed in common areas and parking garages¹.

For the CIEEP-Ecology Action, CIEEP-Enovity, HER, and EMPower programs, TRC used the same NTGR values as the program for the ex ante savings. For these programs, TRC's adjustments to net ex ante savings came from adjustments to gross savings. For MPP, TRC's calculated an average NTGR (weighted by kWh of measures) of 64%. This was close, but slightly higher than, the ex ante program average NTGR (60%).

For programs not evaluated, TRC assumed the ex ante net savings values.

Figure 2. Net Annual Demand and Electricity Savings

CPAU Program	Ex Ante			Ex Post		
	Program Average NTGR	Peak Savings (kW)	Energy Savings (kWh)	Program Average NTGR	Peak Savings (kW)	Energy Savings (kWh)
COM-CIEEP - Ecol Action*	80%	293	1,759,098	80%	215	1,595,355
COM-CIEEP - Enovity*	80%	48	1,575,146	80%	59	1,546,337
RES-Home Energy Report*	100%	0	1,283,418	100%	0	1,386,987
COM-EMPower*	80%	66	372,598	80%	61	339,089
COM-Comm. Advantage	80%	0	334,645	N.E.	0	334,645
RES-MultiFamilyPlus*	60%	119	105,514	64%	10	96,387
RES-Smart Energy	60%	0	48,564	N.E.	0	48,564
COM-Gen T&D	100%	8	70,460	N.E.	8	70,460
RES-REAP Low Income	80%	0	22,907	N.E.	0	22,907
COM-Bus. New Constr.	85%	0	24,273	N.E.	0	24,273
RES-Home Effic. Genie	42%	0	3,513	N.E.	0	3,513
Total	84%	534	5,600,135	85%	352	5,468,516

*Programs evaluated by TRC

I.1.2 Natural Gas Savings

Figure 3 shows ex ante and ex post natural gas savings for the programs evaluated². These savings include interactive effects – i.e., the increase in heating use, because efficient interior lighting and appliances release less waste heat. Note that TRC also included interactive effects in the electricity (kWh) and demand (kW) calculations. The kWh and kW savings are slightly higher due to reduced cooling needs.

¹ Although the TRM recommends assuming the residential NTGR (54%) for all multifamily lighting measures, TRC assumed the nonresidential lighting measure NTGR (80%) for lighting measures installed in common areas and parking garages, because these areas are considered nonresidential spaces by Title 24 and the decision makers and their decision criteria would be more similar to nonresidential customers.

² CPAU did not provide ex ante natural gas savings for the programs that TRC did not evaluate.

The CIEEP – Enovity and HER programs generated the majority of natural gas savings. The MPP also contributed natural gas savings through ceiling insulation, although TRC reduced program therm savings because of the interactive effects (negative therms) from the lighting measures in this program. EMPower has negative natural gas savings due to interactive effects, because almost all projects in the program are lighting.

TRC’s primary adjustments to gross natural gas savings were (in order of significance):

- ◆ Reductions to natural gas savings because of interactive effects. None of the programs accounted for natural gas interactive effects (i.e., negative therm savings) although the programs generally used electricity (kWh) and demand (kW) factors that included interactive effects. For consistency, TRC assumed interactive effects for natural gas (therms), electricity (kWh), and demand (kW) calculations for all interior lighting projects in conditioned areas. Including interactive effects also aligns with recommended values in the California Municipal Utilities Association Technical Reference Manual (referred to here are the “TRM”)¹, and the California Public Utilities Commission (CPUC) reporting procedures. The inclusion of interactive effects reduced natural gas savings in the CIEEP –Ecology Action, EMPower, and Multifamily Plus programs. Portfolio level² interactive effects totaled -22,976 therms, representing 8% of portfolio level natural gas savings. Without interactive effects, portfolio natural gas savings would be 298,727 therms.
- ◆ Adjustments to controls projects in the CIEEP programs increased or decreased natural gas savings.
- ◆ Adjustments to the HER program savings calculation: TRC removed the attribution factor from the calculation because the methodology already produced net savings, which increased savings. TRC also used FY2016 residential natural gas use, instead of FY2015, which decreased savings. Overall, TRC increased HER natural gas savings compared to ex ante calculations.
- ◆ Reductions to the MPP: TRC reduced the area compared with the program to exclude insulated area over unconditioned space (e.g., over covered parking areas or exterior walkways). In addition, the ex ante therm savings reported by the program, 21,810 therms, was not supported by the program database, which showed a total ex ante savings of 17,917 therms. Because the MPP database did not provide support for the additional 3,993 therms, TRC removed them from ex post savings.

For net savings, CPAU has historically assumed a 100% NTGR for natural gas savings. The rationale is that natural gas equipment is typically capital intensive, and natural gas is relatively inexpensive, which should both decrease the likelihood that the participant would have installed the same equipment in the absence of the program.

However, for FY 2016, the equipment in CIEEP that produced natural gas savings also produced electricity savings. It is unknown whether the customer was motivated by electricity savings, natural gas savings, or a combination of both. For consistency, TRC assumed the kWh NTGR for calculating therm

¹ Energy and Resource Solutions, “Savings Estimation Technical Reference Manual for the California Municipal Utilities Association”, 2014.

² Based on programs evaluated. Other programs, including the Commercial Advantage Program (CAP), may also have had interactive effects.

savings for CIEEP projects. Similarly, for the lighting projects in EMPower, MPP, and CIEEP, TRC applied the kWh NTGR when calculating the negative therm savings from interactive effects.

The one measure where TRC assumed 100% NTGR for natural gas savings was ceiling insulation projects installed in MPP. The TRM (following DEER 2014 precedent) provides kWh and therm savings for residential ceiling insulation projects, and uses a NTGR of 28%. However, the CPAU MPP ceiling insulation measures were installed in buildings that did not have air conditioning. Consequently, these participants were only motivated by natural gas savings. In addition, from TRC's survey of MPP participants, the two respondents that had installed ceiling insulation reported they would not have installed the measure if they had been required to pay a portion of the cost. Consequently, TRC followed historical CPAU policy and assumed 100% NTGR for these projects. (As described above, TRC calculated no kWh savings for these projects.) TRC also calculated higher net therms for MPP than gross therms, because the net-to-gross adjustment reduced the interactive effects (i.e., resulted in a smaller negative savings) from lighting measures, but there was no net-to-gross adjustment from ceiling measures.

For programs not evaluated, TRC used the NTGR for kWh savings.

Figure 3. Gross and Net Annual Natural Gas Savings

CPAU Program	Ex Ante	Ex Post		
	Gross Savings (Therms)	NTGR	Gross Savings (Therms)	Net savings (Therms)
COM-CIEEP - Ecol Action*	14,725	80%	92	73
COM-CIEEP - Enovity*	117,447	80%	115,994	92,795
RES-Home Energy Report*	116,925	100%	135,779	135,779
COM-EMPower*	0	80%	-2,300	-1,840
COM-Commercial Advantage	4,430	80%	4,430	3,544
RES-MultiFamilyPlus*	21,810	116% ¹	10,777	12,498
RES-Smart Energy	4,046	60%	4,046	2,409
COM-Gen T&D	0	-	0	0
RES-REAP Low Income	4,451	80%	4,451	3,561
COM-Business New Construction	0	-	0	0
RES-Home Efficiency Genie	2,484	42%	2,484	1,039
Total	286,317	91%	275,751	249,858

*Programs evaluated by TRC

I.1.3 Lifecycle Savings

Figure 4 shows gross and net lifecycle savings. To calculate lifecycle savings for the programs evaluated, TRC multiplied the annual savings for each measure by the measure Effective Useful Life (EUL). TRC

¹ The NTGR is over 100%, because the measure providing positive therm savings (ceiling insulation) had a NTGR equal to 100%, while the measure providing negative therm savings (lighting projects through interactive effects) had a NTGR of 64%. Applying the NTGR therefore reduced only the negative therms.

obtained the EUL values for each measure from the Northern California Power Agency (NCPA) Energy Efficiency Reporting Tool. TRC also confirmed these EUL values using DEER 2014.

For programs not evaluated, TRC assumed the ex ante lifecycle savings.

As shown in Figure 4, TRC calculated a much lower lifecycle savings than the ex ante calculations showed for EMPower and (to a lesser extent) MPP. Furthermore, TRC's lifecycle kWh savings realization rates were lower than annual kWh savings realization rates for these programs. The primary reasons for the adjustments for lifecycle savings included the following:

- ◆ **Adjustments to lighting measure EUL based on operating hours for EMPower and MPP.** For the ex ante lifecycle savings estimate for lighting measures, the EMPower program assumed the measure EUL without adjusting for the operating hours of where the measures was installed. For example, for LED lamps, the programs generally assumed 15 years, regardless of where the LEDs were installed. For the ex post lifecycle savings estimate, TRC adjusted the EUL based on the operating hours, according to customer verified lighting system run time. For example, for an LED lamp installed in an area for which lighting operates 4,350 hours per year, TRC divided 20,000 hours (the rated lifetime of an LED lamp¹) by 4,350 to estimate a measure life of 4.6 years. The majority of the lifecycle savings reductions for EMPower were because of this adjustment. The MPP program may have also assumed the maximum measure life for lighting measures (e.g., 15 years for LED lamps), regardless of operating hours. However, the program did not provide project-level ex ante lifecycle savings calculations, so TRC could not determine the EUL assumed for MPP. TRC adjusted the EUL based on DEER 2014 stipulated operating hours.
- ◆ **Adjustments to annual savings.** All of TRC's adjustments to annual kWh savings also affected lifecycle kWh savings.

¹ California Public Utilities Commission (CPUC), 2014. "EUL-RUL Calculating DEER Values for Lighting 2014-02-05".

Figure 4. Gross and Net Lifecycle Energy Savings

CPAU Program	Ex Ante Lifecycle		Input Values for Ex Post Lifecycle		Ex Post Lifecycle		
	Gross Savings (kWh)	Net Savings (kWh)	Ex Post Annual Gross Savings (kWh)	Average Measure Life (Yr)	Gross Savings (kWh)	Net Savings (kWh)	Gross Realization Rate (%)
COM-CIEEP - Ecol Action*	22,932,235	18,345,788	1,994,193	7.5	15,009,974	12,007,979	65%
COM-CIEEP - Enovity*	4,409,633	3,527,706	1,932,921	2.2	4,252,931	3,402,345	96%
RES-Home Energy Report*	1,283,418	1,283,418	1,386,987	1.0	1,386,987	1,386,987	108%
COM-EMPower*	6,927,045	5,541,636	423,861	5.6	2,354,837	1,883,869	34%
COM-Commercial Advantage	6,274,590	5,019,672	418,306	N.E.	6,274,590	5,019,672	N.E.
RES-MultiFamilyPlus*	2,460,068	1,283,178	150,840	9.9	1,497,575	956,950	61%
RES-Smart Energy	767,180	357,133	81,540	N.E.	767,180	357,133	N.E.
COM-Gen T&D	3,523,000	3,523,000	70,460	N.E.	3,523,000	3,523,000	N.E.
RES-REAP Low Income	277,911	222,329	28,633	N.E.	277,911	222,329	N.E.
COM-Business New Construction	428,340	364,089	28,556	N.E.	428,340	364,089	N.E.
RES-Home Efficiency Genie	145,534	57,656	8,400	N.E.	145,534	57,656	N.E.
Total	49,428,954	39,525,606	6,524,697	4.2	35,918,858	29,182,010	73%

*Programs evaluated by TRC

I.2 Key Findings

Based on our evaluation results, the realization rates for savings were fairly high. In particular, programs with high savings (CIEEP and HER) had high realization rates. The final realization rates and major contributors to savings adjustments are as follows:

- ◆ 97% of total ex ante annual electricity (kWh): TRC adjusted the baseline of lighting measures so that they met current federal regulations, which reduced savings, particularly for the CIEEP-Ecology Action and EMPower lighting measures. TRC also removed kWh savings for ceiling insulation measures in MPP, because the program installed them in buildings without air conditioning. However, TRC's correction in the savings methodology increased savings from the HER program. Overall, portfolio kWh savings slightly decreased.
- ◆ 66% of demand (kW): The primary reductions were in the MPP, which had a kW realization rate of 10%, and in the CIEEP-Ecology Action program, to account for the coincident demand factor. Most of the kW reductions for other programs were due to adjustments that also affected electricity (kWh) savings.
- ◆ 96% of natural gas savings (therms): TRC reduced natural gas savings by including interactive effects (negative therm savings) in the CIEEP-Ecology Action, EMPower, and MPP programs. In addition, TRC reduced CIEEP-Enovity savings from some controls measures due to operational changes, and reduced MPP savings to remove savings from ceiling insulation over unconditioned spaces and to correct for a database reporting issue. However, TRC increased natural gas savings for HER compared to program claims, because of a correction in the savings methodology. Overall, portfolio natural gas savings slightly decreased.
- ◆ 73% of lifecycle kWh savings: The primary adjustment was because TRC reduced the EUL of lighting measures by accounting for the operating hours for the space types in which they were installed, whereas some programs assumed maximum measure lives. Secondly, most of the annual kWh reductions also reduced lifecycle savings.

TRC provides more detail and a description of all adjustments in each program chapter, and program recommendations based on the evaluation findings in Section 9.

2 INTRODUCTION

The objective of this project was to verify FY 2016 demand, electricity, and natural gas savings claims. To meet this goal, TRC verified annual and lifecycle gross and net impacts.

The primary purpose of this project was to meet CPAU's reporting requirements to the CEC. In addition, CPAU will use the findings for internal tracking purposes and to make improvements to programs going forward.

2.1 Overview of Programs Evaluated

For FY2016, TRC conducted impact evaluations of four programs and a process evaluation of one program. TRC collaborated with CPAU staff to identify programs for evaluation at the annual planning meeting on August 22, 2016. In general, TRC and CPAU prioritized a program for evaluation if it:

- ◆ Had high ex ante savings. TRC evaluated four of the five programs with the highest ex ante savings.
- ◆ Was not evaluated in FY2015.

Consequently, TRC evaluated the three programs with the highest savings (CIEEP, HER, and EMPower). TRC did not evaluate the program with the fourth highest energy savings (Commercial Advantage Program), because TRC evaluated it in the FY2015 evaluation. Instead, TRC evaluated the program with the fifth highest savings (Multifamily Plus), because this program had not been evaluated recently and had undergone program design changes.

Section 10.1 in the Appendix provides a more detailed description of why TRC and CPAU did or did not select each program for evaluation in FY 2016.

Below, TRC provides a summary of each program evaluated.

- ◆ **CIEEP** provides energy assessments and incentives for custom efficiency projects to large customers. CIEEP is a subprogram within the Commercial Advantage Program (CAP) that is available to customers with buildings larger than 30,000 square feet and/or with a maximum electric demand greater than 50 kilowatts (kW). Incentives are calculated based on installed and verified energy savings. Three third party implementers were qualified to provide projects through the program. In FY2016, Enovity delivered twenty-five measures through nine projects, Ecology Action delivered eight measures through five projects, and BASE did not complete any projects.
- ◆ **Home Energy Report (HER) Program** provides residential customers with reports regarding their energy use and encourages them to take behavioral or measure-based actions to reduce energy consumption. CPAU had provided the HER program for several years but stopped sending reports to customers at the end of FY2015. As described in the program chapter (Section 4.3), previous studies have found that some energy savings persist after discontinuation of the reports.
- ◆ **EMPower** provides small and medium businesses with incentives for lighting, vending, HVAC, and controls upgrades, as well as technical assistance. Program participants receive an energy audit, through which energy upgrades are identified. A program trade ally – i.e., a participating contractor – installs the recommended upgrades and receives the program rebates. This program is an expansion of the RightLights Plus program provided in FY2015. In FY 2016, fifteen projects participated, almost all of which installed lighting measures.

- ◆ **Multifamily Plus Program (MPP)** provides direct install savings measures. The program eligibility requirements changed during FY2016: In the beginning of FY2016, commercial buildings could participate, but the program later restricted eligibility to multifamily buildings. In 2016, approximately 32 customers participated through ninety-eight projects installed at fifty-nine buildings¹. The bulk of savings came from multifamily (not commercial) buildings, and all FY2016 savings were from lighting measures and ceiling insulation.
- ◆ **Home Efficiency Genie (Genie)** provides residential customers with phone-based and in-person efficiency consulting services, and assistance in efficiency improvements. The program includes a direct install component where the implementer installs energy and water savings measures (e.g., LEDs and faucet aerators) as part of the in-person assessment. Following the assessment, the program provides ongoing assistance for completing recommended upgrades. In FY2016, 105 customers participated, primarily in the assessment and direct install component of the program.

2.2 Methodology Overview

Figure 5 shows the total number of projects verified for each program evaluated, and TRC's overall approach to verifying each program. TRC followed the program database naming convention when referring to a project. For CIEEP, a project referred to a site; most sites had multiple measures. For EMPower and MPP, a project referred to a measure.

Figure 5. Number of Projects Verified by Program

CPAU Program	Total Projects in FY 2016	Verified On-site	Verified by Desktop Review only	Total Projects Verified
CIEEP – Enovity	9	3	4	7
CIEEP – Ecology Action	5	3	1	4
EMPower	15	4	0	4
Multifamily Plus	98	42	0	42
Home Energy Report	N/A	N/A	N/A	N/A
Total	127	52	5	57

To conduct EM&V for FY2016, TRC used the following overall methodologies:

- ◆ For custom savings projects in the CIEEP program:

¹ Based on unique addresses. The number of participating multifamily properties was smaller, because some multifamily properties had multiple addresses.

- For all projects, TRC reviewed trend data and compared actual operating conditions to the operating conditions assumed in the ex ante calculations; and verified, or adjusted as-necessary, the baseline energy efficiency assumptions.¹
- For a sample of projects, TRC conducted on-site verifications for a sample of projects, in which we compared the number, efficiency, and location of the measures installed versus the claimed values.
- ◆ For deemed savings projects in EMPower and MPP, TRC identified a sample of projects for verification. For this sample, TRC:
 - Conducted on-site verifications, in which we compared the number, efficiency, and location of the measures installed versus the claimed values.
 - Reviewed the savings algorithm and assumptions to ensure that operating hours matched DEER savings values, and that the baseline energy use was appropriate (as detailed in each program chapter).
- ◆ For HER program, TRC used the percent of energy saved through HER treatment that Navigant (2012)² calculated previously for CPAU, but updated the relevant calculation parameters based on FY2016 energy use, and applied a persistence factor because CPAU stopped sending HER reports at the end of FY2015.
- ◆ TRC also conducted electronic surveys of participants to gather feedback for two programs:
 - For the Genie process evaluation, TRC worked with program staff to send a survey invitation to all 105 participants. A total of 27 participants responded to the survey.
 - For the MPP, TRC worked with program staff to send a survey invitation to ten participants. This included the five participants that TRC worked with to coordinate site visits, and five participants for which the program database had an email address. (For the remaining participants, the program database did not have an email address, so TRC could not administer the survey.) A total of three participants responded to the survey.

The program-specific chapters provide more detail.

For lighting measures, TRC used the following approach for baseline assumptions:

- ◆ TRM 2014 (including TRM calculator) baseline wattages for T8 lighting, and for medium-screw based lamps (e.g., A-lamps and reflectors) unless they were not compliant with the federal regulations given in the Energy Independence and Security Act (EISA) or the Incandescent Reflector Lamp (IRL) regulations.
- ◆ Use baseline wattages that are minimally compliant with EISA and IRL, if the TRM 2014 baseline is noncompliant. Consequently, TRC did not use an incandescent lamp as the baseline condition (unless the specific lamp type was exempt from these regulations). Instead, TRC assumed a

¹ As described in Section 3.2, TRC could not obtain sufficient trend data to verify current conditions for four measures installed as part of three projects: three measures from Enovity and one from EA. For the CIEEP-Enovity measures, TRC assumed the realization rate from other CIEEP-Enovity controls measures. For the CIEEP-EA measure, TRC reviewed the calculations and inputs to ensure that they were reasonable and assumed a realization rate of 100%.

² Navigant, prepared for CPAU: "Evaluation of the Home Energy Report Program", 2012.

minimally compliant wattage (i.e., the least efficient lamp that complied with EISA or IRL). The rationale is that EISA and IRL have been in effect in California for 2.5 years before FY2016 began. The medium-screw based lamps in the projects reviewed had hours of operation at least 1,800 hour per year¹. Incandescent lamps have a rated life of ~1,500 hours, so have an estimated lifetime of less than one year in these spaces.

¹ One exception was in the residential lamp replacements that occurred in the OC project in the MPP program. However, the vast majority of in-unit savings were from a lamp type that is exempt from EISA and IRL, so TRC accepted the existing condition.

3 CIEEP

3.1 Program Overview

The Commercial and Industrial Energy Efficiency Program (CIEEP) provides energy assessments and incentives for custom efficiency projects to large customers. The program has three (3) third party implementers: Enovity, Ecology Action (EA), and BASE, although BASE did not complete any projects in FY2016. CIEEP is available to customers with buildings larger than 30,000 square feet and/or with a maximum electric demand greater than 50 kilowatts (kW). Incentives are calculated based on installed and verified energy savings, typically at a rate of \$0.10 per kWh and \$1.00 per therm saved over one year.

In FY 2016, there were fourteen projects with thirty-three measures. Two third party vendors, Enovity and EA, implemented the program in FY 2016. Enovity primarily implemented controls projects and equipment replacements. The majority of savings from EA projects came from lighting measures, with additional savings coming from controls projects and variable frequency drive (VFD) installations.

For the nine projects for Enovity and five projects for EA, the implementers conducted an audit, developed a report identifying potential energy savings measures, and developed a final report showing the savings from the projects as installed. Implementers calculated energy savings using custom spreadsheets and the Custom Building Optimization Analysis Tool (C-BOA) developed by the California Commissioning Collaborative.

3.2 EM&V Approach

The fourteen projects for this program collectively accounted for the largest savings in the CPAU FY 2016 portfolio. TRC reviewed all fourteen projects, and conduct site visits at six to verify equipment installation and collect operational trend data. For the balance of the projects, TRC conducted desk-based reviews of all submitted documentation including reports, calculations, equipment submittals, as-built plan sets, and current trend data when available. Although TRC attempted to verify a census of the thirty-three measures, for four controls measures (three from Enovity and one from EA), TRC could not obtain sufficient trend data to verify savings. For the Enovity measures, TRC applied realization rates based on other CIEEP-Enovity controls measures. For the EA measure, because there were few other controls measures in the CIEEP-EA program, TRC reviewed the calculation to confirm that it was correct and that inputs were reasonable, and applied a realization rate of 100%. The project-specific write-ups provide more detail.

Prior to the site visits, TRC reviewed the project investigation and verification reports and calculations (e.g., Excel spreadsheets) to become familiar with project scope, calculation methodology, and savings for each of the implemented measures. During the on-site field visits, TRC:

- ◆ Conducted brief staff interviews to determine any major operational or occupancy changes since measure implementation;
- ◆ Visually verified lighting and equipment installation quantity, make, and model;
- ◆ Reviewed Energy Management System (EMS) schedules and settings; and
- ◆ Obtained or requested EMS trend data, screenshots, and equipment performance and specification product submittals.

For the ex post savings, TRC used the data we collected to verify calculation and model inputs and to make the necessary changes to revise the savings to reflect current operating conditions.

As part of our verification, TRC reviewed the baseline assumptions used in the ex ante savings calculation and made adjustments where necessary. In general, TRC:

- ◆ Assumed existing conditions as the baseline for optimization projects, because these projects did not trigger code. The ex ante savings calculations were also developed using existing conditions, so TRC generally did not make baseline adjustments for optimization projects.
- ◆ Assumed code-compliant equipment as the baseline for installation / replacement of large equipment, because this activity would have triggered Title 24¹. The program included a few instances where Title 24 would not have been triggered (e.g., an economizer was repaired on existing equipment); TRC assumed existing conditions for such cases. The ex ante savings calculations were developed using existing conditions for most equipment installations, but in some cases, the existing equipment met Title 24.

These adjustments and others are discussed in more details in this chapter.

3.3 Overview of Program EM&V Results

Figure 6 and Figure 7 provide annual ex ante and ex post gross savings for each CIEEP-Enovity, and CIEEP-Ecology Action project, respectively. Figure 8 provides combined results from both implementers.

Overall, TRC calculated a decrease in annual savings from 4,167,807 kWh to 3,927,114 kWh, resulting in a gross realization rate of 94% kWh savings (98% for Enovity and 91% for EA) compared with ex ante claims. TRC's kWh adjustments were primarily because:

- ◆ There were differences in operating conditions – e.g., supply temperature, fan flow operation, economizer operation, zone deadband set points, duct static pressure or supply air temperature set points, or operating hours assumed in the ex ante calculation did not match current conditions, based on TRC's analysis of trend data.
- ◆ EA Project 1068 used the existing wattages of the incandescent lamps replaced as the baseline. Under the Energy Independence and Security Act (EISA) of 2007, baseline wattages for replaced incandescent lamps cannot exceed EISA guideline maximums. TRC lowered the baseline wattages in the calculations which reduced kWh savings. Details for this can be found in the project write-up below.
- ◆ EA did not account for HVAC heating and cooling interactive effects in some interior lighting projects, which slightly increased kWh cooling savings.

CIEEP had a lower realization rate for annual kW (91%) than for annual kWh (94%).

- ◆ The primary reduction in kW savings was because EA did not include coincident demand factors in its kW demand calculations.

¹ Based on permitting dates, both Title 24-2008 and 2013 were applicable to this program FY2016. Title 24-2013 went into effect on July 1, 2014. Program FY2016 includes projects permitted both before and after that date. The appropriate code year is referenced in this report if a particular measure triggered code.

- ◆ In addition, project 1068 contributed the majority of kW savings (367 ex ante kW, or 86% of program total), and had a low realization rate (74%) because of the baseline adjustment.
- ◆ These reductions in program kW were partially offset because TRC identified demand savings from four measures (1058 EEM-10, 1064 EEM-4, and 1065 EEM-4 and 5) for which the implementer had not claimed any demand savings.

TRC's adjustments decreased natural gas savings from 117,447 to 116,085 therms for a program realization rate of 99% for natural gas (99% for Enovity, and -34% for EA). The majority of natural gas savings came from CIEEP-Enovity projects. The adjustments in natural gas savings were because:

- ◆ For CIEEP-EA projects, the ex ante calculations did not include heating offset interactive effects, but TRC incorporated them for ex post savings, resulting in a heating (therms) penalty. Because the negative therms from lighting projects outweighed the positive therm savings from CIEEP-EA projects, the CIEEP-EA natural gas realization rate is negative. However, the overall adjustment for interactive effects (-15,895 therms for the CIEEP program) is relatively small compared to overall CIEEP program natural gas savings (14% of 116,085 therms).
- ◆ Several of the differences in operating conditions that affected kWh savings also affected natural gas savings.

Sections 3.4 and 3.5 provide more detail on TRC's findings and adjustments for each CIEEP - Enovity and CIEEP - EA project, respectively.

Figure 6. CIEEP-Enovity Results

Project	Measure	Controls (C) or Installation (I)	Verified Controls Measures	Description	Ex Ante 1st Year Gross Savings			Ex Post 1st Year Gross Savings			Realiz. Rate (% kWh)	Net-to-Gross	Ex Post 1st Year Net Savings			Measure Life	Gross Lifecycle kWh	Net Lifecycle kWh
					kW	kWh	Therms	kW	kWh	Therms			kW	kWh	Therms			
1051	EEM-1	C	X	Revise AH Operating Schedules	-	163,788	7,237	-	163,788	7,237	100%	80%	-	131,030	5,790	1	163,788	131,030
	EEM-2	C	X	Optimize Fan Speed Control On Both AH Units	1.9	22,034	-	1.8	22,034	-	100%	80%	1	17,627	-	1	22,034	17,627
	EEM-3	I		Repair Economizer Operation For Both AH Units	4.0	28,611	-	4.5	28,611	-	100%	80%	4	22,889	-	1	28,611	22,889
	EEM-4	I		Repair VAV Box Control	4.0	27,500	100	4.3	27,500	100	100%	80%	3	22,000	80	1	27,500	22,000
1051 Subtotal					9.9	241,933	7,337	10.6	241,933	7,337	100%		8.5	193,546	5,870		241,933	193,546
1054	EEM-1	C		Tighten Operating Schedules At AHU 06/07 And Implement Afterhours Override Switches	-	13,500	-	-	13,500	-	100%	80%	-	10,800	-	1	13,500	10,800
	EEM-3	C		Implement Demand Control Ventilation At	-	4,700	-	-	4,700	-	100%	80%	-	3,760	-	1	4,700	3,760
	1054 Subtotal					-	18,200	-	-	18,200	-	100%		-	14,560	-		18,200
1058	EEM-5	C	X	Shorten Unit Operating Hours	-	52,100	3,000	-	47,800	2,400	91.7%	80%	-	38,240	1,920	1	47,800	38,240
	EEM-6	C	X	Recode Economizer Sequence	-	48,100	24,600	-	42,500	24,000	88.4%	80%	-	34,000	19,200	1	42,500	34,000
	EEM-7	C	X	Implement New Sat Reset Sequence	-	26,000	2,200	-	29,800	5,900	115%	80%	-	23,840	4,720	1	29,800	23,840
	EEM-8	C	X	Implement New Static Pressure Reset Sequence	-	111,700	7,200	-	107,000	6,000	95.8%	80%	-	85,600	4,800	1	107,000	85,600
	EEM-9	C	X	Implement Dual Max Sequence At VAV Boxes	-	-	5,500	-	-	5,400	n/a	80%	-	-	4,320	1	-	-
	EEM-10	C	X	Increase VAV Zone Temperature Deadband	-	57,700	4,900	13.2	51,547	4,397	89.3%	80%	11	41,238	3,517	1	51,547	41,238
1058 Subtotal					-	295,600	47,400	13.2	278,647	48,097	94%		10.5	222,918	38,477		278,647	222,918
1059	EEM 1	I		Replace 3 Existing Freezers With New Freezers	-	7,100	-	-	7,141	-	101%	80%	-	5,713	-	11	78,551	62,841
1062	EEM-1	I		Replace Boiler #1 And #2 With High-Efficiency Units	-	-	12,070	-	-	12,070	n/a	80%	-	-	9,656	20	-	-
1070	EEM-3	C	X	Shut Off One Of The Two CHW Pumps	1.6	14,300	-	1.6	14,300	-	100%	80%	1	11,440	-	1	14,300	11,440
	EEM-4	C		Implement Air Flow Setback In Operating Rooms	-	52,800	-	-	52,800	-	100%	80%	-	42,240	-	1	52,800	42,240
1070 Subtotal					1.6	67,100	-	1.6	67,100	-	100%		1.3	53,680	-		67,100	53,680
1071	EEM-1	I		Implement Equipment Schedule	-	75,300	-	-	28,500	-	38%	80%	-	22,800	-	1	28,500	22,800
	EEM-2	C	X	Chiller Replacement (Above T-24)	4.0	6,000	-	4.0	6,000	-	100%	80%	3	4,800	-	1	6,000	4,800
1071 Subtotal					4.0	81,300	-	4.0	34,500	-	42%		3.2	27,600	-		34,500	27,600
1069	EEM-1	I		Replace Existing Hhw Boiler With Two New High-Efficiency Units (Above T-24)	-	-	7,680	-	-	4,940	n/a	80%	-	-	3,952	20	-	-
	EEM-2	I		Install VFD On Existing Hhw Pumps	3.2	27,900	-	3.2	27,900	-	100%	80%	3	22,320	-	15	418,500	334,800
	EEM-3	I		Install VFDs On Existing Chw Pumps	-	48,300	-	-	48,300	-	100%	80%	-	38,640	-	15	724,500	579,600
1069 Subtotal					3.2	76,200	7,680	3.2	76,200	4,940	100%		2.6	60,960	3,952		1,143,000	914,400
1067	EEM-1	C	X	Tighten HVAC Schedules And Implement Afterhours Override Switches	-	1,031,600	34,680	-	1,059,300	35,270	103%	80%	-	847,440	28,216	1	1,059,300	847,440
	EEM-2	I		Chiller Replacement And Load Shifting	41.4	62,200	-	41.4	62,200	-	100%	80%	33	49,760	-	20	1,244,000	995,200
	EEM-4	C	X	Increase Economizer Lockout Temp To 70f At HTA, HTC, HTE, HTF	-	8,400	-	-	8,400	-	100%	80%	-	6,720	-	1	8,400	6,720
	EEM-5	C	X	Increase Zone Temperature Deadband	-	79,300	8,280	-	79,300	8,280	100%	80%	-	63,440	6,624	1	79,300	63,440
1067 Subtotal					41.4	1,181,500	42,960	41.4	1,209,200	43,550	102.3%		33.1	967,360	34,840		2,391,000	1,912,800
Enovity Total					60	1,968,933	117,447	74	1,932,921	115,994	98%		59	1,546,337	92,795		4,252,931	3,402,345

Figure 7 presents savings from EA Projects.

Figure 7. CIEEP-Ecology Action Savings Results

Project	Measure	Controls (C) or Installation (I)	Verified Controls Measures	Description	Ex Ante 1st Year Gross Savings			Ex Post 1st Year Gross Savings			Realiz. Rate (% kWh)	Net-to-Gross	Ex Post 1st Year Net Savings			Measure Life	Gross Lifecycle kWh	Net Lifecycle kWh
					kW	kWh	Therms	kW	kWh	Therms			kW	kWh	Therms			
1068	EEM-5	I		New-Int-LED-General/Area Lighting	366.5	815,806	-	191.9	604,646	(7,558)	74%	80%	154	483,717	(6,046)	9	5,441,815	4,353,452
1056	EEM-1	I		Lighting Retrofit/New-Ext-LED-Other	-	378,067	-	39.0	392,093	(4,169)	104%	80%	31	313,675	(3,335)	12	4,705,122	3,764,097
	EEM-2	C		Implement Cooling Tower Sequence Optimization, Chiller Sequence Optimization, Condenser Water Temperature Reset	-	610,780	-	-	610,780	-	100%	80%	-	488,624	-	1	610,780	488,624
1056 Subtotal					-	988,847	-	39.0	1,002,873	(4,169)	101%		31.2	802,299	(3,335)		5,315,902	4,252,721
1055	EEM-1	I		Install Lighting EMS [interior]	-	214,275	-	-	214,275	-	100%	80%	-	171,420	-	8	1,714,200	1,371,360
1064	EEM-4	I		Install VFDs on HVAC Supply Fans	-	42,464	-	10.7	34,916	3,326	82%	80%	9	27,933	2,660	15	523,747	418,998
	EEM-5	I		Interior LED Lighting Retrofit and Controls	-	4,085	-	-	4,085	-	100%	80%	-	3,268	-	8	32,680	26,144
1064 Subtotal					-	46,549	-	10.7	39,001	3,326	84%		8.6	31,201	2,660		556,427	445,142
1065	EEM-4	I		Install VFDs on HVAC Supply & Exhaust Fans	-	114,071	-	25.6	114,071	8,493	100%	80%	20	91,257	6,794	15	1,711,065	1,368,852
	EEM-5	I		Interior LED Lighting Retrofit and Controls	-	19,326	-	1.2	19,326	-	100%	80%	1	15,461	-	14	270,565	216,452
1065 Subtotal					-	133,397	-	26.8	133,397	8,493	100%		21.4	106,718	6,794		1,981,630	1,585,304
Ecology Action Total					367	2,198,872	-	268	1,994,193	92	91%		215	1,595,355	73		15,009,974	12,007,979

Figure 8 presents combined savings from Enovity and EA projects.

Figure 8. CIEEP Savings: Combined Results from Enovity and Ecology Action Projects

Description	Ex Ante 1st Year Gross Savings			Ex Post 1st Year Gross Savings			Realiz. Rate (% kWh)	Net-to-Gross	Ex Post 1st Year Net Savings			Measure Life	Gross Lifecycle kWh	Net Lifecycle kWh
	kW	kWh	Therms	kW	kWh	Therms			kW	kWh	Therms			
Enovity Total	60	1,968,933	117,447	74	1,932,921	115,994	98%		59	1,546,337	92,795		4,252,931	3,402,345
Ecology Action Total	367	2,198,872	-	268	1,994,193	92	91%		215	1,595,355	73		15,009,974	12,007,979
Program Total	427	4,167,805	117,447	342	3,927,114	116,085	94%		274	3,141,691	92,868		19,262,905	15,410,324

3.4 Enovity Projects

This section provides a description of the EM&V results for each project that participated in the CIEEP-Enovity program in FY 2016. Many of these projects include HVAC system controls improvements. TRC reviewed nine Enovity projects (sixteen measures), and was able to verify seven projects. As described below, TRC did not have sufficient trend data to verify two controls projects, so applied the realization rate from other Enovity controls projects that we could verify.

3.4.1 Project 1051 (1406-03.1)

The facility is a two-story, 42,416 square foot commercial office building. The building is a steel framed structure with exterior glazing. Space types include open and enclosed offices, conference rooms, break rooms, a kitchen, and restrooms. The built-up HVAC system consisted of two Air Handling Units (AHUs) with VAV boxes and economizers. The implemented energy savings measures included:

- ◆ EEM-1: Revise Operating Schedules for AHU 1 & 2
- ◆ EEM-2: Optimize Fan Speed Control on AHUs 1 & 2 Supply Fans
- ◆ EEM-3: Repair Economizer Operation for AHUs 1 & 2: repaired and/or replaced linkage and actuators
- ◆ EEM-4: Repair Variable Air Volume (VAV) Box Control

The implementer performed savings calculations for these measures in the CBOA Tool and custom Excel spreadsheets. TRC visited the site to verify system type and measure installation and collect EMS trend data. TRC used EMS trend data to confirm the calculation inputs. The analyzed data included EMS schedule screenshots, fan speed, supply, return, and outside air temperatures, and AHU outside air and VAV box damper positions. TRC confirmed that the operation and schedules for the EEM's matched the values claimed at verification, and made no adjustments.

The ex ante savings calculations for the EEMs used existing conditions for the baseline because they were all optimization or repair projects. The implementer used trend data to establish baselines for all the measures including runtime, fan speed, outside air damper position, and VAV box CFM. TRC agreed that the use of existing conditions was appropriate. The total site project kWh realization rate is 100%.

3.4.2 Project 1054 (0609-007-072) Stanford Med Falk

The facility is a two-story, steel-framed, rectangular building with exterior glazing at all four walls. The first floor consists of laboratories and the second floor consists of open and enclosed offices. Other spaces include a library / conference room, restrooms, and a lobby. The facility receives chilled water from a COGEN plant at Stanford University and steam from its central plant boiler for heating at the zone level. This project focuses on three of the building's twelve AHUs that serve the second floor office space and library. The implemented energy savings measures included:

- ◆ EEM-1: Revise Operating Schedules for AHUs 6 & 7
- ◆ EEM-2: Implement Demand Control Ventilation for AHU 08

The project verification report showed ex ante savings of 13,500 kWh for EEM-1 and 4,700 kWh for EEM-2, for a project total of 18,200 kWh. The report also shows natural gas savings, but because Stanford University (not CPAU) provides natural gas to this customer, there are no natural gas savings for CPAU.

The implementer performed savings calculations for these measures using custom Excel spreadsheets. TRC was not able to obtain new EMS trend data to verify current set points and schedules. Consequently, TRC assumed a realization rate based on thirteen other verified Enovity controls projects to calculate the kWh savings for this project. Based on this approach, the kWh realization rate for Enovity controls projects was 1.00. Consequently, TRC calculated kWh savings for Project 1054 by multiplying the ex ante kWh by 1.00 to calculate 13,500 kWh.

The total site project kWh realization rate is 100%.

3.4.3 Project 1058 (0609-007-068)

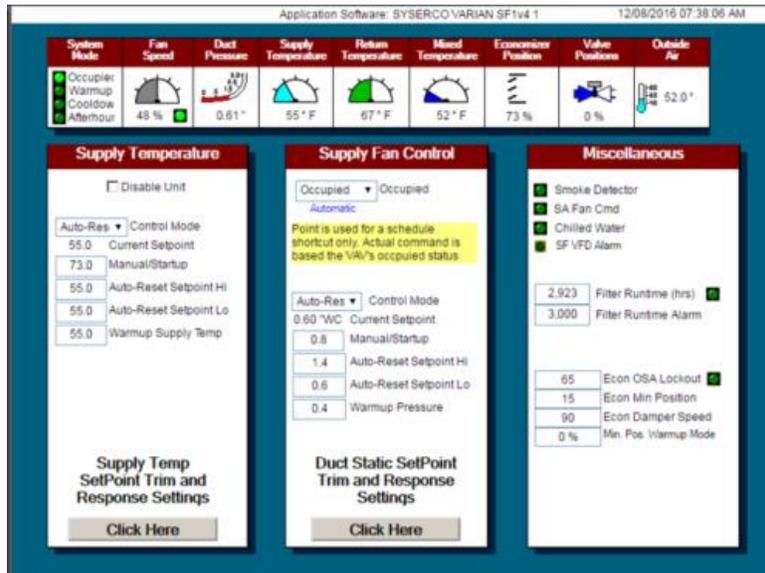
The facility is a rectangular shaped building comprised of high-bay manufacturing areas along with supporting laboratories and offices, receiving and storage areas, and testing facilities. The total facility size is approximately 162,000 square feet. The central plant consists for two chillers, two cooling towers, and three boilers. The energy savings measures apply to the airside systems that include eleven of the sixteen AHUs and their associated zones. Proposed measures 1-4 were not implemented. The implemented energy savings measures for this project were:

- ◆ EEM-5: Reduce HVAC Operating Hours: SF-1, SF-3, SF-4, SF-6.5, SF-7, SF-8, SF-9, AHU-1, AHU-2
- ◆ EEM-6: Increase Economizer Outside Air Lockout Temperature from 61 to 70 degrees: SF-1, SF-9, AHU-1, AHU-2, AHU-3
- ◆ EEM-7: Implement New Supply Air Temperature (SAT) Reset Sequence: SF-1, SF-4, SF-6.5, SF-7, AHU-1, AHU-2, AHU-3
- ◆ EEM-8: Implement Duct Static Pressure Reset: SF-1, SF-6.5, SF-7, SF-8, SF-9, AHU-1, AHU-2, AHU-3, AHU-4
- ◆ EEM-9: Implement Dual Max Sequence for VAV Boxes at Zone Level: SF-1, SF-6.5, SF-7, SF-8, SF-9, AHU-1, AHU-2
- ◆ EEM-10: Increase VAV Zone Temperature Deadband: SF-1, SF-4, SF-6.5, SF-7, SF-8, SF-9, AHU-1, AHU-2, AHU-3, AHU-4

The implementer performed savings calculations for these measures in the CBOA Tool and custom Excel spreadsheets. TRC visited the site to verify system type and measure installation and collect EMS trend data. TRC used EMS trend data and screenshots to confirm the current facility operation and set points. TRC found the verification inputs for EEM-5, EEM-8, and EEM-9 to be consistent with the data. For the other three measures, TRC found some settings discrepancies.

For EEM-6, TRC found the economizer outside air (OA lockout temperature for unit SF-1) to be lower than what was calculated at the verification stage. As seen in the screenshot below, The “ECON OSA Lockout” is set for 65 degrees as opposed to the 70 degree set point used in the ex ante calculation.

Figure 9. 1068 EEM-6 SF-1 Economizer Set Point in CIEEP 1058 EEM-6



TRC changed the Econ OSA lockout temp from 70 to 65 in the model and recalculated for ex post conditions which reduced the ex ante savings by 5,600 kWh and 600 therms.

For EEM-7, the supply air reset parameters had been changed for multiple AHUs, as seen in Figure 10 below and confirmed by examples of EMS screenshots.

Figure 10. 1058 EEM-7 Supply Air Reset Temperature Settings

Unit	Ex Ante Setting		Ex Post Setting	
	Lo	Hi	Lo	Hi
SF-1	60	60	55	55
SF-4	58	65	58	75
SF-6.5	55	65	55	70
SF-7	55	65	55	70
AHU-1	55	68	55	75
AHU-3	65	55	60	70

Figure 11. 1058 EEM-7 SF-1 EMS Screenshot

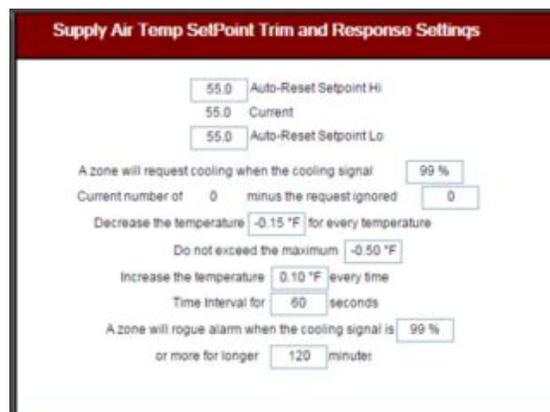


Figure 12. 1058 EEM-7 SF-4 EMS Screenshot

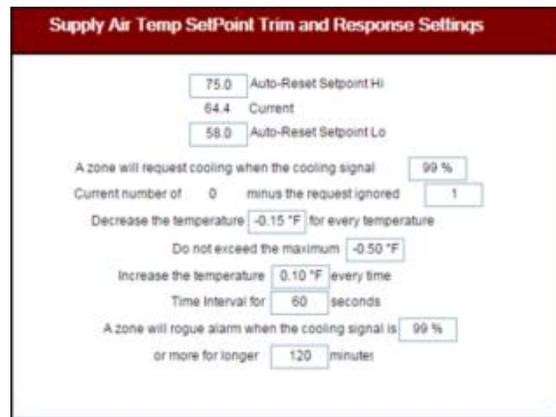
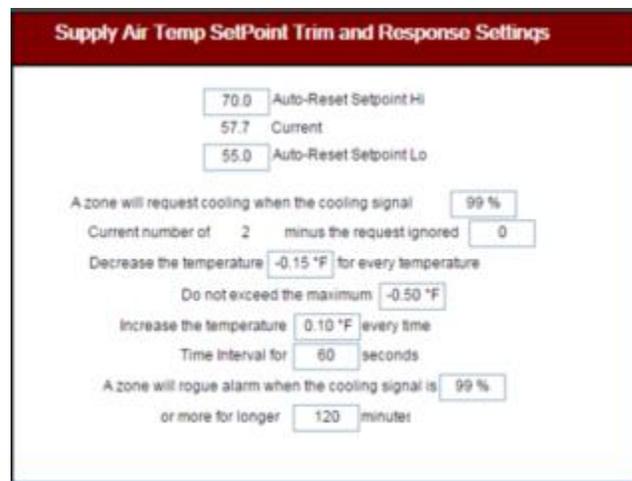


Figure 13. 1058 EEM-7 SF-6.5 EMS Screenshot



TRC made the necessary changes to the supply air reset in the models and recalculated the proposed conditions which resulted in an increase in savings of 3,800 kWh and 3,700 therms.

For EEM-10, data showed a change in deadband temperature range for three units which are listed below.

Figure 14. 1058 EEM-10 Deadband Temperature Range

Unit	Deadband	
	Ex Ante	Ex Post
SF-1	4	2
SF-7	4	1
SF-9	4	3

The deadband range is the sum of the “Heating Offset” and “Cooling Offset” inputs. Examples of the changed setting can be seen in the EMS screenshots below.

Figure 15. 1058 EEM-10 SF-7 EMS Screenshot

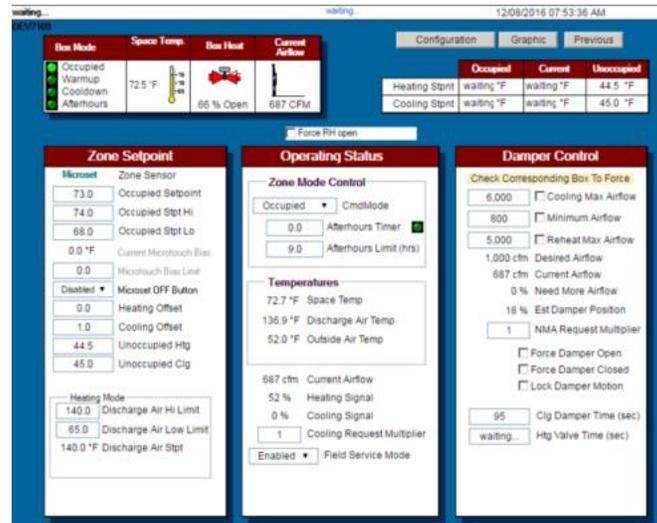
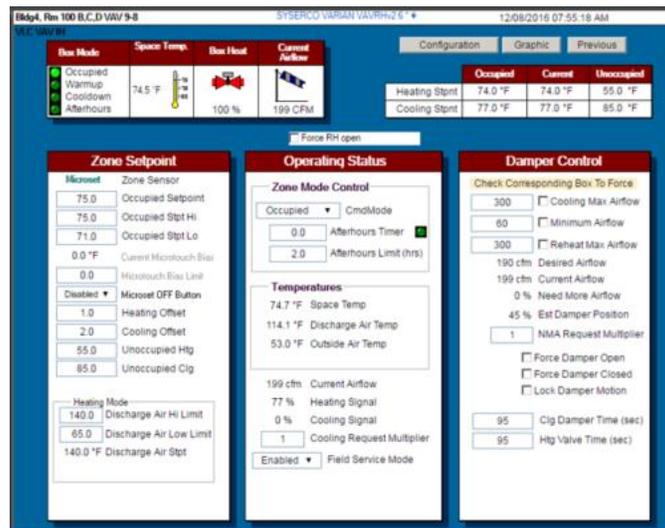


Figure 16. 1058 EEM-10 SF-9 EMS Screenshot



TRC made the necessary changes to the calculations which resulted in a reduced savings of 6,153 kWh and 503 therms.

The ex ante savings calculations for the EEMs used existing conditions as the baseline. The implementer used EMS trend data for building operating schedules and supply air and zone air temperature to establish these baselines. As all of the EEMs are optimization projects, TRC agrees that the use of existing conditions is appropriate.

Although there were no operational discrepancies with EEMs 5, 8, and 9 as mentioned above, TRC did find differences between the CPAU reported ex ante numbers and the implementer’s verification calculations. These differences have an overall negative impact on the realization rate. These are listed in Figure 17 below.

Figure 17. 1058 Reporting Discrepancies

	Ex Ante		Ex Post		
	kWh	therms	kWh	therms	Realization Rate
EEM-5	52,100	3,000	47,800	2,400	92%
EEM-8	111,700	7,200	107,000	6,000	96%
EEM-9		5,500		5,400	
Total	163,800	15,700	154,800	13,800	95%

Based on the revisions described above, the overall realization rate for this project is 95%.

3.4.4 Project 1059 (0609-007-004)

The facility consists of Buildings A and B which are both two-story rectangular buildings. Laboratories comprise about two-thirds of the buildings, and the remainder is primarily offices, including open offices and private offices. The implemented energy savings measure for this project was:

- ◆ EEM-1: Replace 3 Existing Freezers with High-Efficiency Units – serving process loads for School of Medicine in Building A

The implementer performed savings calculations for this measure using custom Excel spreadsheets. TRC reviewed all of the provided documentation including equipment procurement invoices and equipment power draw to confirm calculation methodology and accuracy. TRC did not conduct a site visit, but used the implementer's pre and post installation power draw data to confirm the measure. TRC agrees with the verification results.

This equipment replacement for commercial freezers is mandated by Title 20-2014 code, which allows for approximately 169 kWh of energy use per day at the site voltage of 220. The power draw of the existing units was 2.3 kW, which is lower than the allowed code maximum of 7.0 kW¹. The implementer used logged power data to establish this baseline for the calculation. TRC accepts the methodology and savings results.

The kWh ex ante savings in the verification report were 7,100, but the verification calculation shows a total of 7,141. TRC used the verification calculation for the ex post savings which gives a project kWh realization rate of 101%.

3.4.5 Project 1062 (I315-04.1A & I315-03.1B)

The site contains multiple buildings, but the scope of this project only included Building 3 and Building 26. These are both two-story buildings that consist primarily of research and development and office spaces. Building 3 is served by two boilers (1 & 2) and Building 26 is served by one boiler (4). The implemented energy savings measure for this project was:

- ◆ EEM-1: Replace three of the existing Boilers with High-Efficiency Units: Building 3 - Boilers 1 & 2 (4 MMBtu/hr capacity, 85% thermal efficiency), Building 26 - Boiler 4 (1.99 MMBtu/hr capacity, 83% thermal efficiency)

¹ As established in Title 20, Section 1605.1 Table A-4

The implementer performed savings calculations for this measure in custom Excel spreadsheets. TRC did not conduct a site visit, but rather used the implementer's documentation, including boiler nameplate information showing efficiency and capacity to confirm the calculation inputs. The savings for this project come from the incremental boiler efficiency difference between a baseline of 80% thermal efficiency from Title 24-2013 code minimum (Table 110.2-k) and the higher performing installed boilers. TRC used photos from the verification to confirm the installation of the equipment. TRC made no adjustments to the baseline assumption because the implementer assumed Title 24-2013 as the baseline.

TRC confirmed the verification results (i.e., did not make adjustments to savings). The project kWh realization rate is 100%.

3.4.6 Project 1067 (0609-007-066)

This site is a multi-building campus of which ten buildings were included in the project. Collectively, they have approximately one million square feet of primarily office space. The central plant has chillers that serve AHUs for buildings CSA, CSB, and CSC. All of the other buildings have AHUs with direct expansion (Dx) coils. The boiler in the central plant serves all of the building. There are a total of 39 AHUs. Four of the five energy savings measures implemented for this project were:

- ◆ EEM-1: Reduce HVAC Operating Hours: AHUs for Buildings CSA, CSB, CSC, CSE, CSF, HTA, HTB, HTC, HTE, HTF
- ◆ EEM-2: Chiller Replacement: replace CH-5 with two air-cooled chillers (120-ton each)
- ◆ EEM-4: Increase OA Economizer Lockout Temperature for Buildings HTA, HTC, HTE, HTF
- ◆ EEM-5: Increase Zone Temperature Deadband for All Buildings

The implementer performed savings calculations for these measures in the CBOA Tool and custom Excel spreadsheets. TRC visited the site to verify system type and measure installation and collect EMS trend data. TRC used EMS trend data and screenshots that included schedules, air and water temperature and flow set point, economizer lockout temperatures, zone deadbands settings, and current operations.

For the chiller replacement project (EEM-2, 4, 5), the site replaced CH-5 with two existing chillers that were onsite but not being used. Using chiller curves, the implementer found that the two chillers running in tandem could serve the load and perform at better part load conditions than the existing chiller. TRC found the verification inputs for EEM-2, EEM-4, and EEM-5 to be consistent with the data.

For the EEM-1 scheduling measure, TRC found some settings discrepancies. Through EMS screenshots, TRC found that certain AHUs had different scheduling inputs than what was verified for the ex ante savings estimates. Figure 18 below shows the units with their ex ante and ex post weekly run hours which were confirmed by the EMS screenshots.

Figure 18. 1067 EEM-1 Annual Operating Hours

Building	Annual Op Hours		
	Ex Ante	Ex Post	% Difference
HTA	3,706	3,445	-7.0%
HTB	3,445	3,432	-0.4%
HTC	3,706	3,380	-8.8%

Figure 19. 1067 EEM-1: HTA Schedule

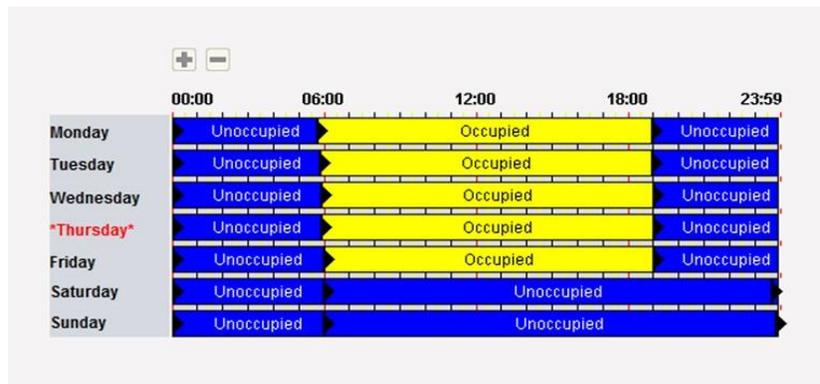


Figure 20. 1067 EEM-2: HTB Schedule

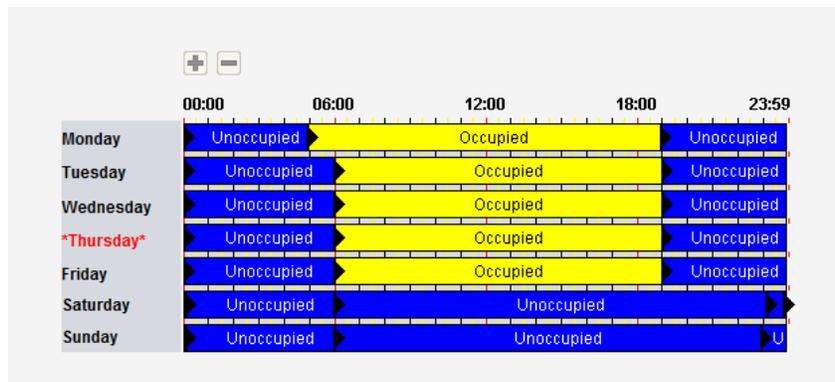
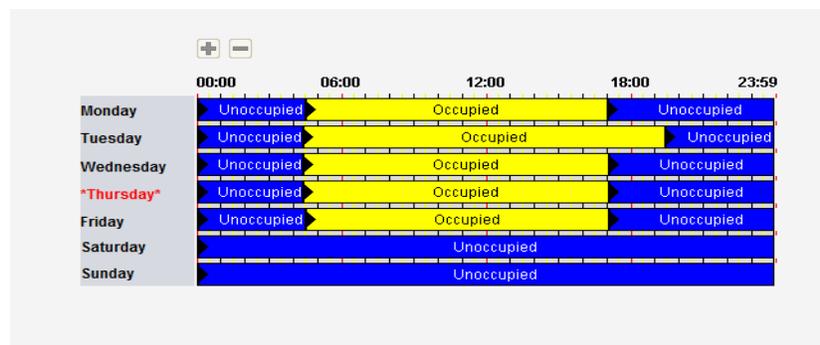


Figure 21. 1067 EEM-3: HTC Schedule



The implementer calculated the savings for the measure using a custom Excel spreadsheet with weather bin data. TRC adjusted the hours per temperature bin for each AHU by the percent differences shown in the table above. The changes to the ex post calculations based on the reduced operating hours resulted in increased savings of 27,700 kWh and 590 therms.

The ex-ante savings calculations for the EEMs used existing conditions as the baseline that the implementer established with EMS trend data for equipment runtime, outside air temperature, economizer changeover temperature, and zone air discharge temperatures. As all of the EEMs are

optimization projects, TRC agrees that the use of existing conditions is appropriate. The overall realization rate for the project is 102%.

3.4.7 Project 1069 (0615-001-005)

The facility is a one-story office building with approximately 25,200 square feet. The HVAC equipment consists of two chillers, two boilers, and one cooling tower – each of which is served by a dedicated pump. The implemented energy savings measures for this project were:

- ◆ EEM-1: Replace Existing Boiler with Two High-Efficiency Units: install two units (2,070Btu/hr ea. capacity and 88% thermal efficiency)
- ◆ EEM-2: Install Variable Frequency Drives (VFD) on Heating Hot Water (HHW) Pumps: for heating hot water pumps P-5 & P-6
- ◆ EEM-3: Install Variable Frequency Drives (VFD) on Chilled Water (CHW) Pumps: for chiller water pumps P-1 & P-2

The implementer performed savings calculations in the CBOA Tool and custom Excel spreadsheets for these equipment installation and retrofit measures. For EEM-1, TRC used the implementer's documentation including trend data and boiler nameplate information to confirm the calculation inputs, including equipment capacity and efficiency. The savings for this measure come from the incremental boiler efficiency difference between a baseline of 80% thermal efficiency from Title 24 2013 code (Table 110.2-k) and the higher performing installed boilers with thermal efficiencies of 88%. TRC did not conduct a site visit, but instead used photos from the verification to confirm installation of the equipment. TRC made no adjustments to the baseline assumption because the implementer assumed Title 24-2013 as the baseline.

EMM-2 and EEM-3 involved the retrofitting of both the CHW and HHW pumps. TRC confirmed this installation with photos provided in the implementer's verification report that showed motor nameplate data and the associate installed VFD for the specific motor. For these retrofit projects, TRC agreed with the existing baseline used by the implementer.

TRC made no adjustments to the calculations, and therefore confirms the verification results. The project kWh realization rate is 100%.

3.4.8 Project 1070 (1407-02.1A)

The facility is a 290,300-square-foot hospital consisting of three levels above grade and one level below grade. Major space types include patient rooms, operating rooms, offices, an auditorium, a kitchen, and a cafeteria. The facility is served by a central plant chiller and multiple air handlers. Air handlers are located in mechanical rooms on the ground floor, the second floor, and the penthouses on the roof. Of the four proposed measures, the two implemented energy savings measures for this project were:

- ◆ EEM-3: Alternate two CHW Pumps: for chiller CH-1 pumps P-15 and P-16
- ◆ EEM-4: Implement Airflow Setback in Operating Rooms: includes seven units (AHU OR-1 through AHU OR-7)

The implementer performed savings calculations for these measures using custom Excel spreadsheets. TRC was not able to obtain new EMS trend data to verify current flow rates and schedules. Consequently, TRC assumed a realization rate based on thirteen other verified Enovity controls projects to calculate the kWh savings for this project. Based on our analysis, the kWh realization rate for other

Enovity controls projects was 100%. Consequently, TRC calculated kWh savings for these measures by multiplying the ex ante kWh by 1.00.

The ex ante savings calculations for the EEMs used existing conditions as the baseline which the implementer established using motor power spot measurements and EMS trend data for AHU CFM. As both EEMs are optimization projects, TRC agrees that the use of existing conditions is appropriate.

No adjustments were made. The total site project kWh realization rate is 100%.

3.4.9 Project 1071 (0609-007-64)

This facility is a two-story, steel-framed, rectangular structure with exterior glazing on all four walls. The first floor is a clinic and the second floor is comprised of open and enclosed offices. The built-up HVAC system includes two chillers, a make-up outside air supply fan, four exhaust fans, and twenty-two fan coil units. The implemented energy savings measures for this project were:

- ◆ EEM-1: Implement Equipment Scheduling from 24/7 to 6 am- 6pm M-F (SF-1 supply fan, 4 exhaust fans, 22 fan coil units, 1 chilled water pump)
- ◆ EEM-2: High-Efficiency Chiller Replacement (CH-1 and CH-2, new efficiencies of 1.15 kW/ton)

The implementer performed savings calculations for these measures using custom Excel spreadsheets. TRC reviewed all of the provided documentation to confirm equipment installation, specifications, hours of operation, and calculation methodology and accuracy. TRC calculated hours of operation from trend data obtained from the site. TRC confirmed the measures with chilled water temperature for the chiller cycling and motor status trend data for the hydronic pumps and fans.

EEM-1 was an optimization project with savings resulting from reduced operating hours for HVAC equipment. As an optimization project, the existing baseline calculated from verification trend data and used by the implementer is appropriate. However, for EEM-1, TRC found discrepancies between the verification data and the data gathered for ex post evaluation. According to the ex post data, none of the equipment schedules were reduced to the proposed (ex ante) hours as seen in the table below.¹

Figure 22. 1071 EEM-1 Annual Operating Hours

Phase	Annual Operating Hours			
	CHW Pump	Supply Fan	Exhaust Fans	FCUs
Ex Ante	3,120	3,120	3,120	3,120
Ex Post	8,760	5,110	5,110	5,384

The changes to the ex post calculations based on the increased operating hours resulted in reduced savings of 27,700 kWh.

The savings for EEM-2 come from the incremental chiller efficiency difference between Title 24-2013 code, Table 4-4 (1.25 kW/ton), and the higher performing installed chiller. TRC made no adjustments to the baseline assumption because the implementer assumed Title 24 2013 as the baseline.

¹ TRC notes that CPAU staff reported that, based on the results of the draft report for this study, the implementer worked with this participant to adjust the equipment schedule to the claimed conditions.

With the adjustments that TRC made to the ex ante calculations, the overall project kWh realization rate is 42%.

3.5 Ecology Action Projects

This section provides a description of the EM&V results for each project that participated in the CIEEP-Ecology Action program in FY 2016. Seven of these projects were lighting measures.

TRC reviewed five Ecology Action projects (eight measures) and was able to verify four of these projects. Section 3.5.4 describes our approach for the fifth project, where we were not able to obtain sufficient trend data.

3.5.1 Project I055

The site is a large corporate campus with a mix primarily of office space, electronics labs and testing areas, and data centers. The recommendations in this report are directed at Buildings 4, 5, 6, and 20. The implemented energy savings measure for this project was:

- ◆ EEM-1: Install Energy Management System (EMS) for Interior Lighting

The implementer performed savings calculations for these measures using custom Excel spreadsheets. For this lighting controls project, TRC reviewed all of the provided documentation to confirm equipment installation, specifications, hours of operation, and calculation methodology and accuracy. The hours of operation are derived from the EMS lighting power feedback. TRC agrees with the verification results.

As a retrofit project, the existing baseline of installed wattage and kW trend data for runtime used by the implementer is deemed appropriate. The total site project kWh realization rate is 100%.

3.5.2 Project I056

This is a multi-functional facility that includes offices and research and development (R&D) areas in three buildings. The HVAC equipment included in the project were chillers CH-3 and CH-4 (640 tons each) and cooling towers CT-1 (610 tons) and CT-3 (815 tons). The implemented energy savings measures included the following:

- ◆ EEM-1: Interior and Exterior Lighting Retrofit: included replacement of interior linear fluorescents and exterior HID fixtures with LEDs
- ◆ EEM-2: Optimize Sequences for Cooling Towers, Chillers, and Condenser Water (CW) Reset

The implementer performed savings calculations for these measures in custom Excel spreadsheets. TRC visited the site to verify equipment and measure installation and collect EMS trend data. TRC used EMS trend data and screenshots to confirm the current facility operation, scheduling, and set points to validate EEM-2. TRC evaluated trend data including cooling tower fan speed, chilled and condenser water temperature, and outside air temperature, and found the verification inputs to be consistent with the data.

The scope for EEM-1 included replacing metal halide exterior fixtures and T8 interior fixtures with LED technology. The implementer used the pre-installation existing condition as the baseline based on an early retirement measure classification. TRC deemed this baseline wattage, fixture type, and count documented with photos by the implementer as appropriate for this project. The implementer validated occupancy and runtime with extensive data logger data. As an optimization project, the existing baseline for EEM-2 used by the implementer is also deemed appropriate.

For EEM-1, kWh ex ante saving reported were 378,067. However, no kW reduction is claimed by the implementer for reduction of interior lighting load which operates during the peak period. TRC calculated 46.2 kW in load reduction, without interactive effects.

The verification calculations for EEM-1 did not include HVAC interactive effects. TRC used the cooling and heating coefficients, 1.0457 and -0.013582 respectively, for commercial indoor non-CFL fixtures from DEER to adjust the ex-ante savings. This resulted in a savings increase of 14,026 kWh and decrease of 4,169 therms. TRC also applied interactive effects and the coincident demand factor to the kW savings, for a final demand savings of 39.0 kW.

The total site project kWh realization rate is 104%.

While the project documentation identified the EUL for EEM-2 (a controls measure) as ten years, CPAU claimed one year for its ex ante lifecycle savings calculation. TRC agreed with the claimed EUL of year, since this is a controls project.

3.5.3 Project 1064

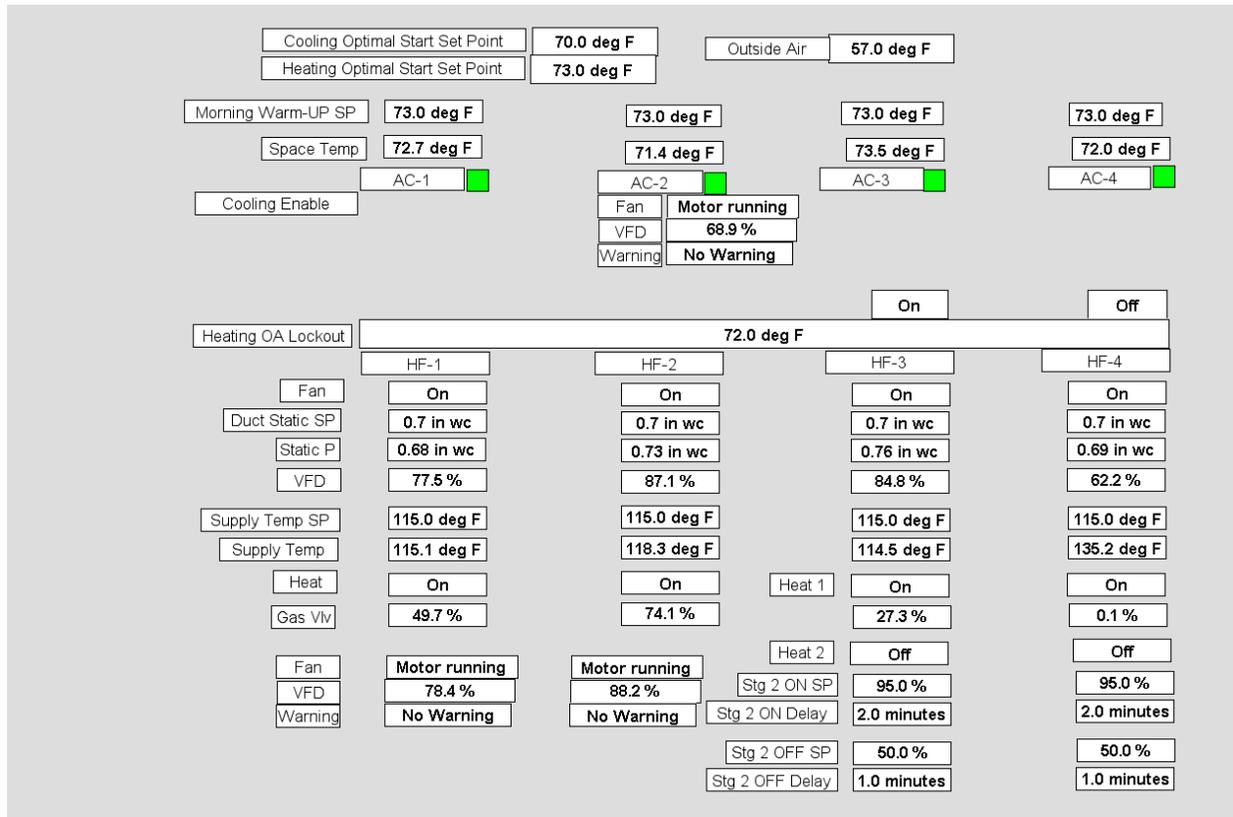
The facility is a 90,000 square foot, two-story office building with two tenants that each occupy an entire floor. The HVAC system consists of four packaged unit .The implemented energy savings measures included the following:

- ◆ EEM-4: Install VFDs on HVAC Supply Fans: includes units AC-1, AC-2, AC-3, AC-4, HF-1, HF-2, HF-3, and HF-4
- ◆ EEM-5: Interior Lighting Controls Retrofit: occupancy sensors for two restrooms

The implementer performed savings calculations for these measures in custom Excel spreadsheets. TRC visited the site to verify equipment and measure installation and collect EMS trend data. TRC used EMS trend data and screenshots to confirm the current facility operation, scheduling, and set points, some of which are provided below. TRC found the verification inputs for hours of operation and installed wattage for EEM-5 to be consistent with the data.

TRC confirmed the VFD fan speeds for EEM-1 from a screenshot from the EMS. As seen below, all of the fans are operating below the baseline condition of 100%.

Figure 23. 1064 EEM-I Set Points



For EEM-4, TRC found a difference between the ex ante schedule and the current operation. The ex ante calculation used a schedule of Monday through Sunday from 7 AM to 9 PM for both HVAC units AC-1 and AC-2. Data showed the current schedules to be Tuesday through Friday from 7 AM- 8 PM for AC-1 and Tuesday through Friday from 7 AM – 5 PM for AC-2. This can be seen in the EMS screenshots below.

Figure 24. 1064 EEM-4 AC-1 Schedule

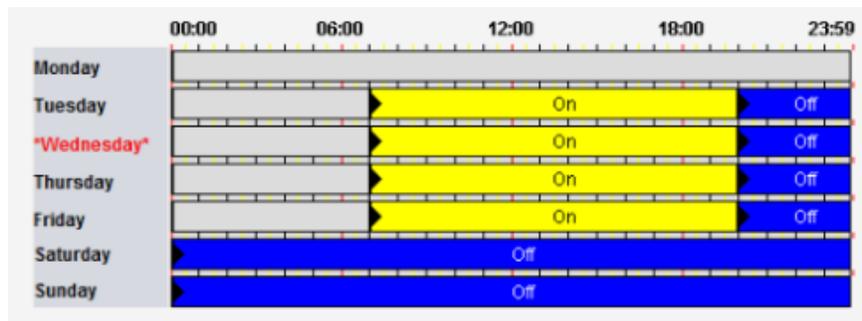
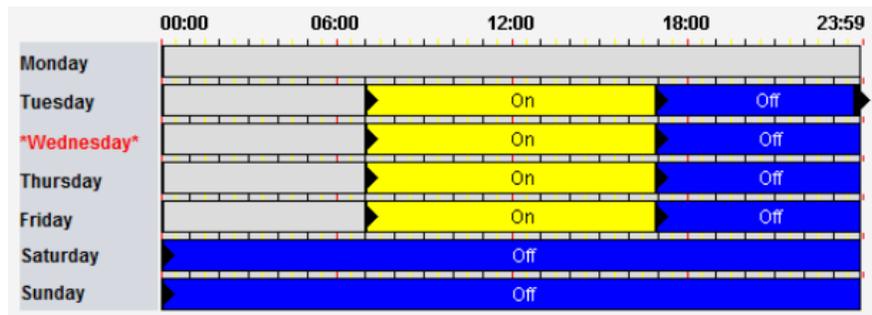


Figure 25. 1064 EEM-4 AC-2 Schedule



These reduced operating hours for the ex post reduced the savings for the measure by 7,547 kWh and 2,907 therms. The larger reduction in therms was because TRC adjusted evening operating hours, when heating would more likely be required.

For EEM-5, the verification calculations did not include HVAC interactive effects. However, this is appropriate for a controls measure and TRC made no adjustments.

As retrofit and optimization projects, the existing baselines of hours of operation extracted from the EMS and from data logger data and the pre-installation lighting wattage used by the implementer are deemed appropriate. The total site project kWh realization rate is 82%.

3.5.4 Project 1065

The facility is a 36,000 square foot, two-story office building which is fully occupied on both floors. The HVAC system is variable air volume (VAV) dual-duct system served by two boxcar units (75 tons ea.) for cooling and two furnaces (720 MBH ea.) for heating with VAV terminal units at the zone level. The implemented energy savings measures included the following:

- ◆ EEM-4: Install VFDs on HVAC Supply Fans and Duct Static Pressure Reset: includes cooling units AC-1 and AC-2, heating units HF-1 and HF-2, and duct static pressure reset for heating ducts
- ◆ EEM-5: Interior LED Lighting Retrofit and Controls: includes replacing linear fluorescents and metal halide fixtures with LEDs and installing occupancy sensors to replace timeclocks

The implementer performed savings calculations for these measures using custom Excel spreadsheets. TRC reviewed all of the provided documentation to confirm equipment installation, specifications, hours of operation, and calculation methodology and accuracy. The implementer calculated the VFD fan speed, duct static pressure, and hours of operation from verification data logging. TRC agrees with the verification results.

EEM-4 is a retrofit and optimization project so the existing baseline of constant fan speed used by the implementer is deemed appropriate. EEM-5 is a combination of early retirement and optimization, so TRC accepted the existing baseline of pre-installation wattage and runtime and occupancy based on data logger data for this measure.

For EEM-4, TRC was not able to obtain new trend data to verify current operation for this controls measure. However, TRC did confirm with the implementer that the building has remained fully occupied and the space use type has remained the same since the time of verification. Based on this information and review of the calculations, TRC accepts the validity of the verification savings for ex post.

For EEM-5, the verification calculations did not include HVAC interactive effects. The project consists of controls and load reduction, however the load reduction only occurred in unconditioned areas (garage, exterior). No kW reduction is claimed by the implementer for reduction of the garage interior lighting load, which operates during the peak period. TRC calculated 1.2 kW in load reduction, which is not subject to interactive effects.

The total site project kWh realization rate is 100%.

3.5.5 Project 1068

The measure presented in this report applies to an independent living facility which is a four-story structure totaling just under 920,000 square feet (192,000 of which is a below grade parking garage). The implemented energy savings measure for this project was:

- ◆ EEM-5.1: Interior LED Lighting Retrofit for Individual Apartments (no common areas)

The implementer performed savings calculations for this measure in custom Excel spreadsheets. TRC verified project savings through an on-site verification and count of the installed measures and a review of the calculation methodology and accuracy. TRC inspected and verified that the installed fixture type and lamp wattage matched what was documented for ex ante savings. The implementer did extensive data logging to calculate annual run hours in these residential units, which TRC reviewed and found to be reasonable and acceptable.

For the ex ante calculations, the implementer used the pre-installation existing conditions as the baseline on the basis of early retirement. However, the project scope was to replace incandescent lamps with LED replacements, so TRC concluded that this project should be considered replace on burnout (ROB) or normal replacement in which case a code compliant baseline should be used. TRC used the Energy Independence and Security Act (EISA) of 2007 guidelines for wattage baselines for incandescent replacements. The table below shows the ex ante wattages used for verification, the EISA wattages that TRC used for the ex post calculations, and the installed LED wattages.

Figure 26. 1068 Baseline and Installed Wattages

Phase	Wattages			
	Entry	Bathroom	Hallway	Corridor
Ex Ante baseline	60	100	65	60
Ex Post baseline (EISA)	43	72	65*	43
Installed	8.5	12	8	8.5

*Based on existing conditions, since exempt from EISA.

An exception to this is the hallway, which has 65W BR-30 lamps in the base case. Reflector lamps are governed by the Incandescent Reflector Lamp (IRL) standard, and the 65W BR-30 is exempt from the standard. Therefore, TRC applied the existing condition (65W) as the baseline in the ex post calculation for this lamp type.

TRC recalculated the savings using these reduced baseline wattages, which reduced the savings for the measure by 211,160 kWh and 95 kW (excluding interactive demand effects kW).

The implementer's verification calculations included kWh interactive but did not include kW load reduction effects nor HVAC interactive effects for heating. TRC used the heating coefficient of -0.01358 therm/kWh for commercial indoor non-CFL fixtures from DEER to adjust the ex ante therm savings,

resulting in -4,169 therms. TRC adjusted the kW by applying the cooling interactive effects factor of 1.25 kW/kWh and the coincident demand factor of 0.845, resulting in an ex post value of 191.9 kW.

The total site project kWh realization rate is 74%.

4 HOME ENERGY REPORT PROGRAM

4.1 Program Overview

The Home Energy Report (HER) Program provides residential customers with reports regarding their energy use and encouraging them to take behavioral or measure-based actions to reduce energy consumption. The reports include a summary of the home's recent and historical energy use, a comparison of the home's energy use to that of similar neighbors, and tips for reducing energy use. The program is implemented by OPOWER, which administers HER programs for various other utilities across California and the U.S.

CPAU contracted with OPOWER to send HER to residential customers in 2010, and OPOWER sent the first batch of reports to customers in late 2010. CPAU discontinued OPOWER's service in 2015; OPOWER sent the last reports to customers in August 2015.

4.2 EM&V Approach

CPAU does not have a control group for the HER program. All eligible customers have received HER treatment. Consequently, TRC could not conduct regression analysis for the FY2016 evaluation. Instead, TRC assumed the percent of energy saved through HER treatment that was calculated when CPAU did have a control group by Navigant (2012)¹. However, TRC updated the relevant calculation parameters based on FY2016 energy use. In addition, because CPAU ceased sending HER reports at the end of FY2015, TRC conducted a literature review to identify a persistence factor for the percent of HER energy savings that continued after HER treatment.

TRC used the following equations to calculate energy savings:

HER Net kWh Savings = (Residential electricity sales in FY2016 x FY2015 HER elec. recipient rate x HER Electricity Savings Rate x HER Persistence factor) – Residential Program Elec. Savings in FY2016

HER Net Therm Savings = (Residential natural gas sales in FY2016 x FY2015 HER nat. gas recipient rate x HER Nat. Gas Savings Rate x HER Persistence factor) – Residential Program Therm Savings in FY2016

Navigant (2012) used regression analysis based on a control group, where the energy savings of the HER treatment group pre and post HER treatment is adjusted by the energy savings over the same time from a control group that did *not* receive treatment. Because this method adjusts for exogenous changes in energy use beyond HER treatment, the result is net savings.² Neither gross savings nor the net-to-gross ratio are calculated using this method of regression analysis. Consequently, TRC assumed that gross savings for HER equaled net savings. This method underestimates gross savings, but provides a conservative estimate of gross savings without further data collection to estimate the net-to-gross ratio.

¹ Navigant, prepared for CPAU: "Evaluation of the Home Energy Report Program", 2012.

² As described in Freeman, Sullivan & Co., "Evaluation of PG&E Home Energy Report Initiative for the 2010–2012 Program (2013): "The regression estimates based on the Randomized Control Trial (RCT) design directly produce a net savings estimate for the treatment conditions. No gross estimates exist. The only adjustment to the net savings estimate is a subtraction for savings claimed by other programs."

TRC removed savings from residential programs to avoid double counting energy savings. The residential program savings are the total savings from the:

- ◆ Residential Smart Energy,
- ◆ Home Efficiency Genie Programs, and
- ◆ In-unit lighting measures in the Multifamily Plus Program (MPP). TRC retained electricity savings from MPP lighting measures installed in common areas and the exterior, as well as natural gas savings from MPP ceiling insulation, because these were installed by the facility manager (not the resident) so would not be influenced by HER treatment. (HER reports were only sent to residential customers.) TRC considered retaining savings from all MPP measures, since all measures were installed by the facility manager, so would not be influenced by HER. However, the lighting measures installed in the units would preclude the residents from installing similar lighting measures due to HER influence. Navigant (2012) calculated the percent of savings due to HER using reductions in customers' electricity bills, and a portion of their savings may have been from lighting savings. In other words, the MPP took savings from lighting measures "off the table", so HER treatment customers (some of which lived in multifamily units) could not generate similar savings. Consequently, TRC removed them to avoid double counting.

TRC also retained savings from the Residential Low Income (REAP) program, because low income customers did not receive HER treatment.

Section 4.3 presents TRC's inputs for the net energy savings equations.

4.3 EM&V Results

4.3.1 Literature Review Findings of HER Persistence Factors

To identify a persistence factor of FY2016 HER treatment savings compared to FY2015, TRC conducted a literature review of HER treatment program studies. TRC identified the following key findings:

- ◆ **Long-run Savings and Cost-Effectiveness of Home Energy Report Programs (Cadmus 2015):** This report reviewed the results of studies that had measured the persistence of savings after HER treatment had stopped in six treatment groups. Four of those groups had received treatment for at least two years before treatment stopped and had annual savings decay in the range of 11-21%. The fifth and six groups received treatment for one year and six months and an annual savings decay of 32% and 83%, respectively. Consequently, results supported annual decay of 20% (i.e., persistence of at least 80%) for groups that had received treatment for at least two years. The authors recommended that utilities assume a 20% decay rate each year for savings, regardless of the length of treatment.
- ◆ **PG&E 2015 Energy Savings Estimates from HER Programs (Nexant 2016):** As part of its 2015 HER evaluation, PG&E conducted a persistence study in May 2014. PG&E randomly assigned customers in the Gamma Dual Standard experimental waves to "Continued" and "Terminated" groups, the second of which did not receive any reports after the launch of the test. The authors found it is reasonable to assume that savings decayed at the rate of about 20% per year.
- ◆ **Evaluation of Year 2 Connecticut Light and Power (CL&P) Pilot Customer Behavior Program (NMR and Tetra Tech 2014):** High use customers received HER for one year. The program discontinued reports for a subgroup after that point. Savings dropped from 2.31% to 2.0% over the next 7 months, equivalent to a 14% drop in 7 months, or a 24% drop in one year.

- ◆ **Home Energy Report OPower Program – Decay Rate and Persistence Study (Navigant 2016):**
This study estimates decay rates for three different groups of Commonwealth Edison Company (ComEd) customers during the annual after HER reports were terminated. The first group had received treatment for 4 years and had a decay rate of 4%, the second had received treatment for 2.5 years and had a decay rate of 2%, and the third had received treatment for one year and had a decay rate of 22%.

Based on these studies, TRC assumed that savings decayed 20% from FY2015 to FY2016 – i.e., a persistence of 80%.

4.3.2 HER Savings Calculations

Figure 27 presents the input values that TRC used to calculate net kWh and net therm savings, as well as the sources for those values.

Figure 27. HER Calculation Input Values and Sources

Parameter	Description and Source	Value for kWh calc	Value for Therm calc
Residential energy sales in FY2016	HER savings are proportional to residential energy use. CPAU staff provided FY2016 residential electricity and natural gas sales.	148,266,385 kWh	9,546,073 therms
FY2015 HER recipient rate	Fraction of CPAU residential customers that received HER reports, as reported by CPAU staff.	0.865	0.89
HER Savings Rate	Percent of residential electricity savings from HER treatment. Based on a study by Navigant (2012) for CPAU which measured electricity savings before and after (pre and post) HER treatment compared to a control group.	1.46%	2.1%
HER Persistence factor	Persistence of savings after HER treatment ends. Based on a literature review (described below), TRC estimated that HER savings would decrease 20% each year after HER treatment ended – i.e., 80% of savings would persist compared with the prior year.	80%	80%
Residential Program Savings in FY2016	To avoid double counting energy savings from other CPAU programs, TRC subtracted the savings from overlapping residential programs – i.e., programs serving customers that receive HER treatment. As described above, TRC combined energy savings from the Residential Smart Energy program, Home Efficiency Genie Program, and measures installed in the residential units in the MPP.	111,001 kWh	6,934 therms

Based on these parameters, TRC calculated the following energy savings from HER for FY2016:

HER Net kWh Savings = [148,266,385 kWh x 0.865 x 80% x 1.46%] – 111,001 kWh = 1,497,988 – 111,001 kWh = 1,386,987 kWh

HER Net Therm Savings = [9,546,073 therms x 0.890 x 80% x 2.1%] – 6,934 therms = 142,713 – 6,934 therms = 135,779 therms

Thus, TRC calculated 1,386,987 kWh and 135,779 therms for net and gross savings for FY2016. The EUL of these savings is one year, so the lifecycle kWh also equals 1,386,987 kWh.

5 EMPOWER PROGRAM

5.1 Program Overview

The EMPOWER Program provides small and medium businesses with incentives for lighting, vending, and refrigeration, as well as technical assistance. Program participants receive an energy audit, through which energy upgrades are identified. The participant pays the contractor for the remainder of the project not covered by the program. EMPOWER is implemented by a third party, Ecology Action, and is an expansion of RightLights Plus from FY2015.

In FY 2016, the program delivered fifteen projects at fourteen sites. Fourteen of the fifteen projects were lighting measures, including replacements of T8 lamps with high efficiency T8 lamps, and replacement of incandescent parabolic aluminized reflector (PAR) lamps with LEDs. The fifteenth project was a refrigeration measure (humidistat control for anti-sweat heaters installed in a grocery store).

5.2 EM&V Approach

TRC verified savings for the EMPOWER program by identifying a sample of projects and conducting on-site verifications for this sample. TRC used results from the sampled projects to calculate kWh, kW, and therm realization rates, which we applied across the program.

5.2.1 Sampling Methodology

TRC used a stratified ratio estimation design to select the sample for the EMPOWER program. Using stratified ratio estimation reduced the total number of projects that TRC needed to verify to reach 90% confidence /10% precision compared to simple random sampling. TRC divided the sample into three strata to create an equivalent percentage of total savings in each stratum. This left only a few projects in each of the top two strata.

Figure 28. EMPOWER Sample Design

Stratum	Total Projects in FY 2016	Sample	Estimated Confidence/Precision
1	1	1	100%
2	3	2	90% / 10%
3	11	1	90% / 20%
Total	15	4	90% / 10%

Overall, the sample achieved 90% confidence and 6% precision for annual kWh savings for EMPOWER. All projects sampled were lighting measures.

For the sample of projects, TRC conducted on-site verifications and a desktop review, as described below. Based on our on-site findings and desktop review, TRC adjusted input parameters for the savings calculation(s) for each project.

5.2.2 On-Site Verification

For the on-site verification of projects with deemed measures, TRC verified that:

- ◆ The number of installed measures claimed had been installed and remained in operation;
- ◆ The lighting wattage met the specifications in program files;

- ◆ The location of the installed measures in conditioned and unconditioned space matched program files, since this influences heating and cooling interactive effects calculations.

For each project sampled, TRC was able to verify all measures at the site – i.e., a census of measures.

5.2.3 Desktop Review

As part of the desktop review, TRC reviewed the savings algorithms to verify that the baseline efficiency assumption was appropriate. For T8 lamps, TRC used TRM baseline assumptions, which assumes a first generation T8 lamp. For incandescent lamps, TRC used the following assumptions for baseline condition:

- ◆ The existing condition if the existing measure met current federal regulations for lighting measures, including the Energy Independence and Security Act (EISA) and the DOE Incandescent Reflector Lamps (IRL) standard.
- ◆ A lamp (or fixture) that met current federal regulations, if the existing lamp was not compliant. These regulations include the EISA standard (for A-lamps) and the Incandescent Reflector Lamp (IRL) standard for PAR and reflector lamps.
- ◆ TRC treated all incandescent lamp installations as replacements, not early retirement, because most of the incandescent lamps replaced would have burned out within the year. Incandescent lamps have short measure lives – approximately 2000 hours based on DEER. The replaced lamps were in room areas with annual hours of use that were typically in the range of 2000-4000 hours. Thus, the remaining useful life of these lamps would generally have been less than one year.
- ◆ For T8 lamp upgrades, TRC selected the baseline and installed fixture wattages from the TRM400 calculator.

For operating hours, TRC accepted the implementer's use of existing hours, as verified with customer affidavit. These operating hours were generally higher than DEER 2014 assumptions for similar nonresidential space types.

As part of the lifecycle energy savings calculation, TRC calculated an EUL specific to each lighting measure installed, by dividing the measure life by the number of annual operating hours assumed for that measure. Based on the NCPA E3 Calculator and DEER 2014, TRC used the following assumptions for measure lives:

- ◆ 50,000 hours for LED fixtures, and
- ◆ 20,000 hours for all LED lamps.

Following DEER 2014, for all lighting measures, TRC assumed a maximum EUL of 15 years. For example, for an LED PAR38 lamp installed in an area with annual operating hours equal to 3,380, TRC calculated the measure-specific EUL as $20,000 \text{ hours} / 3,380 \text{ hours/yr} = 5.9 \text{ years}$.

5.2.4 Interactive Effects

Although the EMPower program did not report ex ante therm savings, many of the projects were interior lighting projects that would have negative therm savings due to interactive effects. Consequently, TRC calculated therm savings for the sampled projects, by identifying the appropriate interactive effects factor from DEER 2014 (i.e., the therm per lighting kWh savings value, based on the building type) and multiplying this factor by the ex post lighting kWh savings value. This resulted in

lower (negative) therm savings. Similarly, TRC calculated kWh and kW interactive effect savings using DEER 2014 interactive effects factors, to account for reduced cooling.

For example, for a project with lighting savings providing 10,000 kWh and 10 kW, and interactive effect factors of -0.00783 therms / lighting kWh, 1.037 cooling kWh / lighting kWh, and 1.185 cooling kW / lighting kW, TRC calculated:

$$\begin{aligned} \text{Natural gas savings (therms)} &= 10,000 \text{ kWh} \times -0.00783 \text{ therms / kWh} = -78 \text{ therms} \\ \text{Annual Energy Savings (kWh)} &= 10,000 \text{ kWh} \times (1.037 \text{ cooling kWh / lighting kWh}) = 10,370 \text{ kWh} \\ \text{Annual Demand Savings (kW)} &= 10 \text{ kW} \times (1.185 \text{ cooling kW / lighting kW}) = 11.9 \text{ kW} \end{aligned}$$

5.3 Overview of EM&V Results

Figure 29 provides results for each EMPower project verified. After applying sampling weights, the overall program realization rate was 91% for annual kWh¹, 92% for annual kW, and 34% for lifecycle kWh.

In general, TRC made the following adjustments, in descending order of significance for annual kWh savings:

1. Increased the baseline wattage for several measures from the existing condition (as assumed by the program) to a lamp that complies with federal regulations. This reduced annual and lifecycle kWh savings.
2. Made a few other minor adjustments, depending on the project. This included adjusting the wattage of the installed lamps for some measures, slightly adjusting the number of measures installed for some projects, and including kWh and kW interactive effects. Some of these adjustments increased annual and lifecycle kWh savings while others decreased savings.

For the lifecycle kWh savings, TRC's most significant adjustment was to the EUL assumed for the installed lighting measures. As described in section 5.2.3, TRC adjusted the EUL of each measure to account for the annual hours of operation. The EULs calculated by TRC ranged from 4.6 years to 7.6 years, depending on the location of the measures installed (since this affects annual operating hours) and the measure installed (e.g., fixtures have longer lifetimes than lamps). In contrast, the program assumed 15 years for all LED lamps and 20 years for all LED fixtures. This adjustment significantly reduced lifecycle kWh savings. Secondly, the annual kWh savings adjustments also affected the lifecycle kWh savings.

TRC also accounted for negative natural gas (therm) savings due to interactive effects, which the program did not report. Consequently, TRC calculated -2,300 therms for the EMPower program, while the program assumed zero therms.

Section 5.4 provides more detail for each project.

¹ The realization rate is slightly different for the sampled projects (96%) compared with the program (91%) because of the different case weights for sampled projects. The lower program realization rate is because the project in the third stratum had a high case weight (because it was the only project sampled in that stratum), and had a lower realization rate (84%) compared to the sampled projects in the first and second strata.

Figure 29. EPower Project EM&V Results – Annual Gross Savings

Project	Measure Overview	No. of measures installed	Measure Efficiency	Operating Hours (facility specific)	Baseline Energy Use	Ex Ante Annual		Ex Post Annual			
						Demand Savings (kW)	Energy Savings (kWh)	Demand Savings (kW)	Energy Savings (kWh)	Realization Rate (% kWh)	Natural Gas (therms)
WB	Replacement of incandescent PAR and MR-16 lamps with LED lamps	Reduced number for one of the four measures from 796 to 792 lamps	✓	✓	✓	31.4	160,087	31.39	157,296	98%	-689
SR	Replacement of incandescent PAR and MR-16 lamps with LED lamps	Increased number for one of the two measures from 340 to 346 lamps	For one measure, reduced wattage from 10W to 9W	✓	✓	11.4	65,092	12.02	67,028	103%	-288
PFI	Replacement of fluorescent T8 lamps with tubular LED lamps	Increased the number of measures from 740 to 744 lamps.	Reduced wattage from 15W to 14.5W	✓	Reduced baseline from 31W to 29W (TRM baseline assumption)	10.4	72,938	7.6	66,472	91%	-896
SPH	Replacement of incandescent PAR and MR-16 lamps with LED lamps	✓	✓	✓	For one measure, reduced Wattage from existing (75 W) to IRL-compliant PAR Lamp (65 W)	6.9	32,143	5.5	27,122	84%	-119
Total for Projects Sampled						60	330,260	57	317,918	96%	-1,991
Total for Program						82	465,747	76	423,861	91%	-2,300

✓ = Confirmed. No adjustments made to Ex Ante calculation parameter.

5.4 Project-Level EM&V Results

5.4.1 Project WB

Project WB was implemented in a small retail store. The owner completed four lighting measures to replace the existing incandescent PAR and halogen reflector lamps with LED lamps, to provide general and display lighting. This project was self-installed by the customer. The program claimed the existing condition for all measures.

TRC verified project savings through an on-site verification of the installed measures and a review of the savings algorithm. The type and wattage of measures installed matched what TRC inspected. TRC confirmed that the existing wattage was the correct baseline, because they comply with current regulations. TRC accepted the customer verified hours of operating used by the implementer.

Based on our on-site verification and desk review, TRC made only one adjustment:

1. Reduced the count slightly for one of the four lamp replacement measures from 796 to 792. For the other three measure types, TRC confirmed that the number of measures installed matched the program claims.

This adjustment slightly reduced annual kWh and kW savings from this project.

For lifecycle kWh savings, TRC calculated measure-specific EULs, which were 5.0 years. This was a significant reduction in EUL compared with the program assumptions (15 years for all measures) and led to a low lifecycle kWh realization rate. In addition, the annual kWh adjustments slightly reduced lifecycle savings.

5.4.2 Project SR

Project SR was implemented in a small retail store. The owner completed two lighting measures to replace the existing incandescent PAR and halogen reflector lamps with LED lamps to provide general, display, and signage lighting. This project was self-installed by the customer. The program claimed the existing condition for all measures.

TRC verified project savings through an on-site verification of the installed measures and a review of the savings algorithm. TRC confirmed that existing wattages should be assumed, because the fixture types comply with current regulations. TRC accepted the customer verified hours of operating used by the implementer.

Based on our on-site verification and desk review, TRC made the following adjustments, in descending order of significance.

1. Reduced the installed fixture wattage for one of the measures (the LED BR30 lamps) from 10 Watts to 9 Watts.
2. Adjusted the count slightly for the LED BR30 lamp replacement measure from 340 to 346. For the other exterior LED lamp replacement measure, TRC confirmed that the number of LED lamps matched the program claims.

Both adjustments slightly increased savings.

For lifecycle savings, TRC calculated measure-specific EULs, which were 4.6 years. This was a significant reduction in EUL compared with the program assumptions (15 years for both measures) and led to a low lifecycle kWh realization rate.

5.4.3 Project PF1

Project PF1 was implemented in a grocery store. The owner completed a lighting measure to replace all existing interior fluorescent T8 lamps with LED tube lamps. The LED lamps provide general and display lighting in the store. This project was self-installed by the customer. The project claimed the existing condition for the measure.

TRC verified project savings through an on-site verification of the installed measures and a review of the savings algorithm. The type and wattage of measures installed matched what TRC inspected. TRC accepted the customer verified hours of operating used by the implementer.

Based on our on-site verification and desk review, TRC made the following adjustments, in descending order of significance:

1. Reduced the baseline wattage for the existing T8 from 31 W to 29W, following the TRM 2014.
2. Reduced the installed fixture wattage for the LED tube lamps from 15 Watts to 14.5 Watts.
3. Increased the number of LED tube lamps replaced from 740 to 744.

The first adjustment decreased kWh and kW savings, while the second and third slightly increased the kWh and kW savings from this project. Overall, kWh and kW savings decreased.

For lifecycle savings, TRC calculated that the measure-specific EUL was 7.6 years. The program claimed 15 years. This adjustment led to an overall reduction in lifecycle kWh savings.

5.4.4 Project SPH

Project SPH was implemented in a small retail store. The owner completed two lighting measures to replace the existing incandescent PAR and halogen reflector lamps with LED lamps. The LED lamps provide general and display lighting. A lighting contractor installed the project. The program claimed the existing condition for all measures.

TRC verified project savings through an on-site verification of the installed measures and a review of the savings algorithm. The type and wattage of measures installed matched what TRC inspected.

Based on our on-site verification and desk review, TRC made the following adjustments, in descending order of significance for kWh savings adjustments:

1. Reduced the baseline lamp wattage for one of the measures – the Incandescent PAR lamps – from the existing wattage (75 W, 1225 Lumen) to an IRL standard compliant wattage (65 W). For the other LED lamp replacement measure, TRC confirmed that the existing wattage was the correct baseline, because it complies with current regulations.

This adjustment reduced kWh and kW savings for the project.

For lifecycle savings, TRC calculated measure-specific EULs, which were both 5.5 years. This was a significant reduction in EUL compared with the program assumptions (15 years for both measures) and led to a low lifecycle kWh realization rate. Secondly, the annual kWh adjustment reduced lifecycle savings.

6 MULTIFAMILY PLUS PROGRAM

6.1 Program Overview

The Multifamily Plus Program (MPP) provides direct install measures primarily to multifamily buildings. In the beginning of the evaluation year (FY2016), commercial buildings were eligible for participation, although program eligibility has since been restricted to multifamily buildings. A third party contractor, Synergy, implements the program.

In FY 2016, ninety-eight (98) projects were installed in approximately sixty (60) buildings, based on unique addresses. Many of these projects and buildings were in the same multifamily property.

The FY2016 savings came from ceiling insulation and lighting measures, including LED and T8 lamp and fixture installations.

6.1 EM&V Approach

TRC verified savings for the Multifamily Plus program by identifying a sample of projects and conducting on-site verifications for the sampled projects. Because some multifamily properties included multiple projects, if a single project at a multi-building/multi-project was selected, TRC verified all projects at each multifamily property installed by the program.

TRC also conducted an electronic survey with a sample of MPP participants, as described in section 6.4.

6.1.1 Sampling Methodology

TRC used a stratified ratio estimation design to select the initial sample for the MPP. Using stratified ratio estimation reduced the total number of projects that TRC needed to verify to reach 90% confidence /10% precision compared to simple random sampling. Of the ninety-eight (98) total projects, TRC identified nine projects for the initial sample:

- ◆ Three of the six project in the top strata,
- ◆ Three of the nineteen projects in the second strata, and
- ◆ Three of the seventy-three projects in the third strata.

The nine projects in the sample were located at four multifamily properties.

Using this sample design, TRC estimated that savings would be verified with 90% confidence, 20% precision.

Because TRC verified all projects at each of the four multifamily properties in the original sample, TRC added 33 projects to the sample. In addition to including these additional projects, TRC made the following adjustments to the original sample:

- ◆ The program contact for one project in the first strata no longer worked at one of the sites. TRC substituted another project in the first strata that had the same facility manager as a project that was already in the sample.
- ◆ For one of the projects in the second strata, the owner declined access. Consequently, TRC identified two back up projects. Both project owners allowed access. Because both projects had smaller kWh savings than the project removed from the original sample, TRC added both to the sample to help ensure that the targeted confidence and precision would be met.

- ◆ TRC could not obtain access to one project in the third strata. TRC selected another project in the third strata that had the same facility manager as a project that was already in the sample.

Based on these changes to the original sample, TRC ultimately evaluated a total of forty-three projects. The original and final sample, by stratum are shown in Figure 30. TRC revised the case weights for each stratum based on the final sampling.

Figure 30. Number of MPP Projects in the Original & Verified Sample

Stratum	Total Projects in FY 2016	Original Sample	Final Sample
1	6	3	3
2	19	3	10
3	73	3	29
Total	98	9	42

Overall, TRC achieved 90% confidence, 32% precision with the projects sampled for annual energy savings. The high (i.e., poor) relative precision was because:

- ◆ One project (Project LG2) had a realization rate greater than 700%.¹ Without this project, the verified savings achieved 90% confidence, 20% precision. Section 6.3 describes adjustments made for each project, including the large adjustment made for project LG2.
- ◆ TRC verified zero kWh savings for ceiling insulation projects, because they were installed in buildings without air conditioning, while the program used kWh savings from the TRM (based on DEER 2014). Because of the large discrepancy in savings for these projects, the relative precision increased.
- ◆ For several lighting projects, TRC calculated significantly different values (sometimes higher, sometimes lower) than what the program calculated. This range in project realization rates led to high relative precision.

6.1.2 Comparison with Ex Ante Claims

The program database provided kW, kWh, and therm savings for each project. For ceiling insulation projects, the implementer provided supporting calculations which included the area of insulation and savings per square foot of insulation. Consequently, TRC could compare our insulation calculations with the implementer's to identify differences in the input parameters for the ceiling insulation projects.

For lighting projects, the implementer provided the savings assumptions tables used to calculate kWh savings by measure type, but did not provide the savings calculations for each project. For example, for LGU1, the program database shows the project as, "T8 28W replacing T8 32W 4F2L", that the implementer installed 119 of these measures, and that the program claimed 14,518 annual kWh. But there is no supporting calculation showing how the implementer calculated 14,518 kWh (such as the

¹ TRC designed the sample assuming a realization rate standard deviation based on the CPAU Commercial Advantage Program results in FY2015. However, the actual realization rate standard deviation for the Multifamily Plus program was much greater. Consequently, results had a higher precision, even though TRC verified more sites than were in the original sample.

baseline or installed wattage, hours of use, or other assumptions). Consequently, TRC could not identify the specific input parameters that differed between our calculations and the implementer's for lighting projects that led to the ex ante versus ex post savings discrepancies.

6.1.3 Verification Methodology

To verify energy savings for the sample of projects identified, TRC conducted on-site measurements and conducted a desktop review. TRC's verification approach varied by measure, as described below.

Ceiling Insulation: For ceiling insulation measures, TRC used on-site observations to verify the type and depth of insulation installed. TRC measured the ceiling area that was insulated using a laser measure of the building length and width, but removing areas that were covered but unconditioned (e.g., covered parking areas or exterior walkways). TRC also developed measurements using roof area shown on Google Earth¹ as another source of verification. Using the Google Earth verification step, results were similar (within approximately 10%). For our savings assumptions, TRC used the on-site laser measurements, because we believed these were more accurate.

To verify the insulation R-value, TRC used Zillow² to obtain the age of each building, and used vintage table values to estimate the existing R-value based on building age. For almost all projects, vintage tables showed that there was no existing insulation, which matched the program claims. For one project, the program claimed existing R-8 insulation, and TRC observed this existing insulation on-site. Consequently, TRC did not make any changes to the baseline condition assumption.

The TRM provides kWh and therm savings for ceiling insulation measures installed in California Building Compliance Climate Zone 4 (Palo Alto). However, none of the sampled projects with ceiling insulation had central or unit air conditioning, so the ceiling insulation measures are not delivering actual kWh savings for most of these projects. Consequently, TRC used zero kWh and zero kW savings from ceiling insulation measures.

Lighting Measures: For lighting measures, TRC used on-site observations to verify that:

- ◆ The number of installed measures claimed had been installed and remained in operation;
- ◆ The installed measure, including wattage, met the specifications in program files;
- ◆ The room locations of the installed measures matched what was claimed, since location affects hours of use. TRC used DEER deemed assumptions for HOU or operating hours (not actual facility operating hours), since MPP is a deemed (not custom) program.
- ◆ The location of the installed measures in conditioned and unconditioned space matched program files, since this influences heating and cooling interactive effects calculations.

For all but one project, TRC was able to verify all lighting measures. For one project, TRC verified a sample of measures, as described in Section 6.3.1.

For T8 lamp upgrades, TRC selected the baseline and installed fixture wattages from the TRM400 calculator. For incandescent lamp replacements, TRC verified that the baseline measure met current federal regulations for lamp efficacy, including the EISA and IRL standards.

¹ www.google.com/maps Similar to the on-site measurements, for the Google Earth calculations, TRC removed roof areas over unconditioned space based on our on-site observations.

² www.zillow.com

Although the TRM recommends assuming residential hours of use for all multifamily lighting measures, TRC assumed nonresidential operating hours for common areas to align with how Title 24 treats these areas. In addition, because almost all exterior lighting was installed in parking areas, TRC believed that the facility's actual operating hours (where available) or nonresidential exterior operating hours were more accurate for these measures than residential exterior lighting hours of use. Consequently, TRC assumed the following for lighting measures installed in the Multifamily Plus program:

- ◆ Residential interior hours of use (541 hours) for measures installed in residential units,
- ◆ Nonresidential exterior operating hours (4,100) for measures installed in parking lots,
- ◆ Nonresidential interior operating hours (4,160) for measures installed in multifamily offices and common areas, such as hallways,
- ◆ Continuous operating hours (8,760) for parking garage lighting based on site inspections. The parking garage lighting was on when TRC visited the site, and the vast majority of the parking garage area did not receive enough daylighting to be illuminated without electrical lighting.

For demand (kW) savings, TRC used the following coincident factors for lighting measures based on DEER 2014 (since the TRM did not provide values):

- ◆ 0.043 for measures installed in units,
- ◆ 0.676 for measures installed in common areas, except for those in a senior housing facility where we assumed 0.565
- ◆ 0.694 for measures installed in offices, and
- ◆ 1.000 for measures installed in parking garages (interior), and 0 for parking lots (exterior).

As part of the lifecycle energy savings calculation, TRC calculated an EUL specific to each lighting measure installed, by dividing the measure life by the number of annual operating hours assumed for the measure. Based on the NCPA E3 Calculator and DEER 2014, TRC used the following assumptions for measure lives:

- ◆ 70,000 hours for LED and T8 fixtures,
- ◆ 20,000 hours for all LED lamps

Following DEER 2014, for all lighting measures, TRC assumed a maximum EUL of 15 years.

For example, for an LED PAR38 lamp installed in an area with annual operating hours equal to 3,380, TRC calculated the measure-specific EUL as $20,000 \text{ hours} / 3,380 \text{ hours/yr} = 5.9 \text{ years}$.

TRC calculated interactive effects (negative natural gas savings) from each sampled lighting project by multiplying the interactive effect factor for each space type (in therms/kWh) by the kWh savings.

6.2 Overview of Program EM&V Results

Figure 31 provides results for each verified MPP project. Extrapolating from the sampled projects to the population, TRC calculated the resulting realization rates of 85% for kWh¹, 10% for kW, 52% for lifecycle kWh, and 49% for therms².

Based on program documentation, TRC can identify the following differences that led to *a portion* of the discrepancy in ex ante and ex post savings:

- ◆ The program did not include interactive effects (negative therm savings) for lighting measures. TRC included interactive effects, which reduced savings by 4,781 therms.
- ◆ The program database shows projects that provide a total of 17,917 therms, but the ex ante savings reported for the program was 21,810 therms. (In other words, the “bottom up” total across projects was 17,917, but the “top down” value reported by the program was 21,810 therms.) The program staff and implementer could not provide supporting documentation for the difference (3,893 therms), so TRC removed these savings in the ex post savings.
- ◆ For ceiling insulation projects, TRC assumed zero kWh and kW savings, which reduced kWh, kW, and lifecycle kWh. In addition, TRC reduced the area of insulation for several projects, which reduced savings by 2,359 therms. The program implementer may have included all insulated roof area, while TRC removed ceiling areas over unconditioned space (e.g., over exterior stairwells or exterior walkways.)

Because project-level savings calculations were not provided for the lighting measures, TRC was not able to identify other differences in assumptions between our calculations and the program savings claims. However, possible differences include:

- ◆ The program may have used different baseline or measure wattage assumptions for lighting measures. For example, for some of the T8 replacements, the implementer claimed savings greater than ten times what TRC calculated. Since TRC assumed 4,000-8760 hours of operation for these lamps (and 8,760 is continuous operation), most of the discrepancy should be from the delta watts claimed by the implementer.
- ◆ TRC assumed a mix of residential interior and exterior hours of use, nonresidential hours of use, and facility hours, depending on the room location of the lighting measures. The implementer may have assumed different hours of use.
- ◆ TRC calculated measure-specific EULs for all lighting measures. TRC used the maximum value for lighting (15 years) for almost all lighting measures. For one LED lamp measure that contributed a large portion of annual kWh savings, TRC calculated an EUL equal to 4.8 years; others calculated to 8.0 or 15.0 years. For parking garage lighting, TRC assumed continuous operation (8,760 hours per year). The program may have assumed 15 years for these measures, which would result in reduced lifecycle kWh savings compared with annual kWh savings.

¹ The average annual kWh realization rate for the projects sampled (88%) differs from the program-level realization rate (85%) because of different case weights for the sampled projects.

² The realization rate for therm savings based on the total in the program database (17,917 therms) was 60%.

Because of the lack of program documentation, TRC was not able to identify the differences in assumptions that led to the very low kW realization rate.

Section 6.3 presents property-level results.

Figure 31. Multifamily Plus EM&V Results by Project- Annual Gross Savings

Project ID	Measure Overview	No. of measures installed	Measure Efficiency	Annual HOU (Based on DEER 2014)	Baseline Energy Use	Ex Ante Annual Savings			Ex Post Annual Savings			
						Demand Savings (kW)	Energy Savings (kWh)	Natural Gas (therms)	Demand Savings (kW)	Energy Savings (kWh)	Realization Rate	Natural Gas (therms)
OC1 to OC 31	Replacement of interior incandescent lamps with LED lamps in units and in common areas, and parking garage fluorescent T8 lamps with high efficiency T8 lamps	✓	✓	Assumed residential interior for tenant units (541 hr), continuous operation for garage (8760 hr), and non-residential interior for common areas and office (4160 hr)	Assumed existing wattage for 65W incandescent to LED replacement, and EISA-compliant wattage for incandescent to LED replacement	41	42,883	0	3	35,130	82% kWh	(383)
LG1-LG4 and LGU1-LG3	Replacement of common area incandescent PAR lamps with LEDs and T8 with High Efficiency T8 lamps	✓	For one measure, reduced wattage from 13 to 11 W	Assumed nonresidential interior for common areas and office (4160 hr), and continuous for garage (8760 hr)	For 50W PAR to LED replacement, assumed existing condition	55	38,693	0	7	44,253	114% kWh	(398)
HA1, HA2 & HA3	Added ceiling insulation	Insulation area reduced from 7,750 to 6,776 sf.	Confirmed therm savings, removed kWh savings	N/A	✓	0	4,007	1,287	0	0	0% kWh, 87% therms	1,125
SQ	Added ceiling insulation	Insulation area reduced from 4,000 to 3,750 sf.	Confirmed therm savings, removed kWh savings	N/A	✓	0	2,068	664	0	0	0% kWh, 94% therms	623
VW	Added ceiling insulation to existing (R-8) insulation	Insulation area reduced from 4,000 to 3,125 sf.	Confirmed therm savings, removed kWh savings	N/A	✓	0	2,020	644	0	0	0% kWh, 78% therms	503
Total for Sampled Projects						95	89,671	2,595	10	79,383	89% kWh, 57% therms	1,470
Total for Program (After Extrapolating from Sampled Projects to Population)						150	176,847	21,810	15	150,840	85% kWh, 49% therms	10,777

✓ = Confirmed.

6.3 Project-Level EM&V Results

6.3.1 Projects OC1 to OC31

Projects OC1 to OC31 were thirty-one lighting measures installed in several low-rise multifamily apartment buildings on one property. Through the program, the owner replaced the interior incandescent lamps with LED lamps in units and in common areas and parking garage fluorescent T8 lamps with high efficiency T8 lamps.

TRC verified project savings through an on-site verification of the installed measures and a review of the claimed savings. The type and wattage of measures installed matched TRC's on-site data collection.

TRC used the following key assumptions for calculating energy savings. Because the program did not provide project-specific calculations for lighting measures, TRC was not able to identify differences between TRC's assumptions and the ex ante assumptions for calculation parameters.

- ◆ For baseline assumptions:
 - For the largest savings measure – 697 occurrences of LED 10-13W replacing 23W or greater halogen downlight (Interior)", TRC did not find any existing lamps on-site (because all lamps had been replaced). However, TRC was able to verify through photographs of removed lamps that the baseline lamps were 65W BR30 lamps. Consequently, TRC assumed the baseline condition was 65 Watts.
 - TRC assumed baseline wattages that comply with current federal regulations, including EISA- and IRL compliant wattages for the incandescent lamp replacement measures. In the previous bullet, the 65W is IRL compliant.
 - For the T8 lamp upgrades, TRC selected the TRM400 baseline values.
- ◆ The hours of use for each measure depended on the area of installation. TRC assumed:
 - Residential interior hours of use (541 hours) for measures installed in residential units, from the TRM,
 - Nonresidential interior operating hours (4,160) from DEER 2014 for measures installed in multifamily common areas,
 - Continuous hours of use (8,760) for measures installed in the parking garages, based on on-site observations.
- ◆ TRC assumed that the number of lamps installed by the program was correct, because we could not confirm the exact quantity. After the FY2016 project (installed prior to July 2016), which replaced some lamps in the multifamily property, the owner conducted another lighting project in FY2017 (installed after July 2016) to replace the remaining lamps. Based on our on-site observations, all of the lamps on this multifamily property were upgraded to LED or high efficiency T8 lamps, but TRC could not discern which lamps were replaced in FY2016 versus FY2017. In addition, some lamps were installed in residential units, to which TRC did not have access. TRC assumed that the number of lamps installed in FY2016 was correct, and will make adjustments to lamp counts in the FY2017 evaluation, assuming the program is evaluated for FY2017 and this property is selected for the EM&V sample.
- ◆ For demand (kW) savings, TRC assumed coincident factors that ranged from 0.043 (for lighting measures installed in units) to 1.00 (for lighting measures installed in continuously operated areas).

- ◆ For interior lighting measures, TRC assumed DEER interactive effect factors depending on the space type.

Based on these assumptions, TRC calculated 35,130 annual kWh, 3.4 kW, and -333 therms for projects OC1 through OC31, which represent realization rates of 82% for kWh and 8% for kW.

6.3.2 Projects LG1-LG4 and LGU1-LGU3

Projects LG1, LG2, LG3, and LG4 (“LG1-LG4”) and LGU1, LGU2, and LGU3 (“LGU1-LGU3”) were installed in senior and assisted living facilities. TRC evaluated the projects together, because the buildings are connected and share common hallways, facilities, and garages. Two lighting measures were installed by a lighting contractor at this facility: 1) replaced the existing parking garage fluorescent T8 lamps with high efficiency T8 lamps, and 2) replaced existing incandescent can PAR downlights with LED PAR lamps in the common area.

The type and wattage of measures installed matched TRC’s on-site observations.

TRC used the following key assumptions for calculating energy savings. Because the program did not provide project-specific calculations for lighting measures, TRC was not able to identify differences between TRC’s assumptions and the ex ante assumptions for calculation parameters:

- ◆ For the LED lamp replacement measure, TRC assumed that the existing lamp (50 W PAR lamp) was the appropriate baseline, because it meets current federal regulations.
- ◆ For the T8 lamp upgrades, TRC used TRM baseline assumptions, which assumes a first generation T8 lamp.
- ◆ TRC assumed that lighting installed in parking garages operated 8,760 hours annually, while lighting installed in Multifamily Common areas used 4,160 hours (for nonresidential interior spaces).
- ◆ For one of the LED lamp measures, the lamps installed had a lower wattage (11 W) compared to the measure description (13 W).

Project LG2 has a large realization rate, so TRC provides our savings calculation for this project here. The project description was “LED 10-13W replacing 50W or greater halogen downlight (Interior)”, and TRC calculated kW savings as follows:

$$(Baseline\ Watts - Measure\ Watts) \times Operating\ Hours \times Number\ of\ Measures \times IE\ (kWh/ lighting\ kWh) = \\ (50\ W - 11\ W) \times 4,160\ hours/yr \times 165\ measures \times 1\ kWh/1000\ Wh \times 1.05 = 28,109\ kWh$$

The program database show ex ante savings equal to 3,360 kWh. Consequently, TRC calculated a realization rate of 744% for this measure.

Based on these assumptions, TRC calculated 44,253 annual kWh, 6.8 kW, and -398 therms for projects LG1-LG4 and LGU1-LGU3, which represent realization rates of 114% for kWh and 12% for kW.

6.3.3 Project HA1, HA2, HA3

Project HA1, HA2, HA3 are three ceiling insulation measures completed in four low-rise multifamily apartment buildings. The buildings are adjacent (i.e., on one property) and have the same owner and manager. The owner hired a contractor to install ceiling insulation to all four multifamily buildings, which previously had no insulation. The program claimed the existing condition (R-0) as the baseline.

TRC verified project savings through an on-site verification of the installed measures and a review of the claimed savings. TRC determined the R-value for the insulation based on the insulation type, density and height. The installed insulation was blown-in rock wool with a loose fill density and 12-14 inches of height, so TRC determined the R-value as R-38. The units had no air conditioning (but had gas furnace space heating), so TRC used zero electricity and demand savings for ex post savings.

TRC calculated the area of insulation using laser measurements taken during the on-site verification. The buildings included covered (but exterior) walkways and stairwells, which TRC removed from the area of ceiling insulation.

Compared with the program claims, TRC adjusted the installed insulation area (ft²) as follows:

- ◆ HA1: Reduced the area from 3,800 ft² (claimed) to 3,402 ft² (verified).
- ◆ HA2: Reduced the area from 2,050 ft² (claimed) to 1,742 ft² (verified).
- ◆ HA3: Reduced the area from 1,900 ft² (claimed) to 1,632 ft² (verified).

These adjustments decreased savings. As the total for the three projects, TRC calculated 1,125 therms, which corresponds to a realization rate of 87% for therms.

The elimination of kWh reduced the ex-post values for this group of facilities from 4,007 to 0 kWh.

6.3.4 Project SQ

Project SQ is a low-rise multifamily apartment building. The owner hired a contractor to install ceiling insulation. The existing baseline condition was no ceiling insulation and the installed is R-38. The program claimed the existing condition (R-0) as the baseline.

TRC verified project savings through an on-site verification of the installed measures and a review of the claimed savings. The R-value for the installed insulation was determined based on the insulation type, density and height. The installed insulation was blown-in rock wool with a loose fill density and 12-14 inches of height. The installed R-value was determined to be R-38. The building has no air conditioning. The space heating was unverified but assumed to be a gas furnace based on the insulated ducts in the ceiling. TRC used zero electricity and demand savings for ex post savings.

TRC calculated the area of insulation using laser measurements taken during the on-site verification. The building included a covered parking area, which TRC removed from the area of ceiling insulation. Based on these calculations, TRC reduced the area of insulation from 4,000 ft² (claimed) to 3,750 ft² (verified).

This adjustment decreased savings. TRC calculated 623 therms, which corresponds to a realization rate of 94% for therms.

The elimination of kWh reduced the ex-post values for this group of facilities from 2,068 to 0 kWh.

6.3.5 Project VW

Project VW is a low-rise multifamily apartment building. The owner hired a contractor to install additional ceiling insulation to the existing R-8 insulation. The project added R-30 insulation for a final insulation value of R-38. The program claimed the existing condition (R-8) as the baseline.

TRC verified project savings through an on-site verification of the installed measures and a review of the claimed savings. The R-value for the installed insulation was determined based on the insulation type, density and height. The installed insulation was blown-in rock wool with a loose fill density and 12-14 inches of height. The installed R-value was confirmed to be R-38. The units had no air conditioning (but

did have space heating by gas furnace), so TRC used zero electricity and demand savings in the ex post results.

TRC calculated the area of insulation using laser measurements taken during the on-site verification. The building included a covered (but exterior) stairwell and walkway, which TRC removed from the area of ceiling insulation. Based on these calculations, TRC reduced the area of insulation from 4,000 ft² (claimed) to 3,125 ft² (verified). This adjustment also decreased savings.

TRC calculated 503 therms, which corresponds to a realization rate of 78% for therms. The elimination of kWh reduced the ex-post values for this group of facilities from 2,020 to 0 kWh.

6.4 Participant Survey Results

To inform program improvement, and to better understand participants' motivations, TRC developed a survey for MPP participants. Because the program database only included email addresses for a few participants, TRC could only administer the survey to a select number of participants. TRC worked with the program staff and implementer to send a survey invitation to ten participants, including the five participants that TRC worked with to coordinate site visits, and five participants for which the program database had an email address. A total of three participants responded to the survey.

TRC emphasizes that these results are anecdotal, given the small number of responses. However, the results provide some preliminary indications of participant motivation and satisfaction. This section summarizes the findings, and full results are provided in Section 10.3 in the Appendix.

All survey respondents were property managers, and they represented a mix of multifamily building size and type (market rate and affordable). Although the survey allowed respondents to check owners or facility managers, all three reported to be rental or property managers. Two served primarily market rate multifamily buildings, while the third served primarily affordable units. The respondents represented a mix of multifamily building sizes.

These participants learned about MPP from contacts from a program representative. Two received a personal visit from a program representative, while the third received a phone call. This agrees with the marketing strategy reported by the implementer, which includes stopping by multifamily buildings in CPAU territory and speaking with facility staff about the program.

Lower energy bills motivated the two participants that installed ceiling insulation, while improved light quality was the primary motivator for the participant that installed lighting. When allowed to select more than one benefit, all three participants selected "lower energy bills", and the lighting participant selected "improved light quality". When asked to identify the primary benefit, the lighting participant selected "improved light quality".

Customers were not willing to pay any, or only a small amount, of the cost to install measures. The two participants that installed ceiling insulation were not willing to pay any incremental cost. The one participant that installed lighting measures (linear T8 fluorescent lighting) was willing to pay approximately one-quarter of the cost.

Respondents reported moderate to high satisfaction with the program, and would be willing to participate again or recommend it to a peer. The average satisfaction rating was 4 (on a 5-point scale). Participants reported they would be likely to participate again (average ranking of 4.7 on a 5-point scale) and they would recommend it to another property manager (average rank of 4.7 on a 5-point scale).

7 HOME EFFICIENCY GENIE PROGRAM

7.1 Program Overview

The Home Efficiency Genie (Genie) program replaces a previous program that provided free home energy audits. The Genie program improves on the previous program by providing a significantly more comprehensive home audit at a greatly subsidized cost, though homeowners do have a co-pay (typically \$149) for the audit portion. The program provides residential customers with phone-based and in-person efficiency consulting services, and assistance in efficiency improvements. Participating customers receive a free phone-based utility bill analysis to identify potential efficiency solutions and prioritize efficiency projects, and a subsidized in-person assessment including air leakage testing, major system and duct inspection, insulation analysis, and energy modeling. Assessments also provide free energy and water savings devices for immediate savings. Customers receive a detailed report explaining how different systems interact, and expert guidance on next steps for further efficiency improvements. Following the assessment, the program implementers stay in regular contact with customers (typically every two weeks, or more frequently depending on the needs of the customer) to provide support for and track progress of any retrofit project efforts. The program provides ongoing assistance as needed in completing any upgrades selected by the customer, including providing a list of pre-vetted recommended contractors, assisting in selection of contractors, reviewing contractor bids, and assisting in securing financing for the upgrade projects. A third party, CLEAResult, administers the program.

Although the Home Efficiency Genie Program heavily subsidizes the cost of the in-home assessment and ongoing customer support, participation in the program precludes customers from participating in other energy efficiency programs offered through CPAU.

7.2 Evaluation Goals

The goals of the process evaluation, as requested by the program manager, were to identify strengths and weaknesses of the program, provide recommendations for improvement, and identify opportunities and effective communication strategies to increase enrollment in the program. The program manager also envisions the Genie program as a go-to resource for customers for all of their home energy, water efficiency, renewable energy, and electric vehicle needs, and hoped to gauge customer awareness of this aspect of the program. Consequently, in addition to including survey questions regarding program strengths and weaknesses, barriers to participation, actions taken because of the program, and how the participant learned about the program, TRC asked whether the customer was aware that the program is a resource for all home energy, water efficiency, renewable energy, and electric vehicle needs¹. Because fiscal year 2016 was the first year for this program, it is still in its early stages, and the program manager and program implementers are both especially interested in how the program can increase enrollment in the future. They are also aware that the process for homeowners to decide on retrofit plans, select contractors, and secure funding for the projects can be lengthy, and that customers who entered the program in fiscal year 2016 may still be in the process of pursuing retrofit projects.

¹ Section 10.2.3 provides the full survey guide.

7.3 Evaluation Methodology

The process evaluation consisted of three primary components: a program manager interview, a program implementer interview, and online customer surveys.

The program manager and program implementer interviews were open-ended discussions focused on program processes, goals for the evaluation, and opportunities to improve the program. The program implementer interview included both the implementation manager, and the program energy advisor who works directly with the homeowners. The program implementer interview also included discussion of customer response and feedback.

TRC worked with CLEAResult to distribute the online survey, because customers are familiar with the program implementer through the ongoing communication and project support. The survey included either 14 or 15 questions (depending on whether respondents had completed any of the retrofits recommended in the assessment report), and was designed to take no more than ten minutes to complete. All questions were five-point satisfaction scale, yes-no, or multiple choice, except for one open-ended comment question at the end of the survey. In addition, some of the satisfaction scale questions had an option for additional open-ended comments. The full online survey questions are included below in the Appendix: Section 10.2.

TRC also reviewed program information, program and participation data, and customer feedback provided by the program manager and program implementer.

7.4 Results and Findings

TRC received survey responses from a total of 27 of the 105 program participants. However, some respondents did not answer every question, so total responses on some questions are less than 27.

In addition, we suspect that some respondents may have reversed the order of the satisfaction scale. In two instances, one respondent reported a “very unsatisfied” rating, but provided positive open-ended comments on the same question. These contradictory responses have been removed from the analysis reported below. In several other instances, respondents provided unsatisfied ratings for aspects of the program without any additional comment, but reported they were “very likely” to recommend program to others. In these cases, we have left those responses in the analysis, but we have noted where they occur in the discussion below.

Customer survey responses are summarized in the key findings below. Where appropriate, feedback from program manager and program implementer interviews are also included in the discussion.

- ◆ **Customers are generally satisfied with the program**

As shown in

Figure 32, customers report very high satisfaction with the home assessment and assessment report aspects of the program.

Instant savings measures received slightly lower satisfaction ratings (10 of 27 reported they were “neither satisfied nor unsatisfied”), due in part to some customers already having efficient lighting and water-saving features installed (five respondents commented that they already had efficient lighting and aerators installed in their homes).

Only one respondent provided negative comments. This respondent reported that a worker dislodged a heating duct in the customer’s attic during the assessment, which required costly repairs. The same

customer reported that only one of three bulbs in a ceiling fixture was replaced, resulting in an undesirable visual appearance.

Figure 32: Home Efficiency Genie Program Satisfaction Ratings

	Very unsatisfied (1)	Somewhat unsatisfied (2)	Neither satisfied nor unsatisfied (3)	Somewhat satisfied (4)	Very satisfied (5)	Average Rating
How satisfied were you with the home assessment you received through the Home Efficiency Genie program?	3*	1	0	2	20	4.35
How satisfied are you with the instant savings measures installed as part of the home assessment (energy efficient light bulbs and faucet aerators)?	3*	1	10	2	10	3.58
How satisfied were you with the report you received following the home assessment?	3*	0	0	1	22	4.50

*Two respondents who reported “very unsatisfied” on these questions also reported “very likely” to recommend the program.

◆ **22 of 27 respondents reported completing at least one of the recommended retrofits**

Based on the program database, only six participants had completed recommended retrofits at the end of FY16 (June 30, 2016). Based on follow-up discussion with the program implementers, a total of 20 customers have gone on to complete program retrofits to date (including the six reported in the original program database). While the bulk of the 22 responses likely came from these 20 customers who have completed retrofits, at least two respondents may have misinterpreted this question and responded based on the instant savings measures, or they may have pursued retrofits on their own that were not reported to the program. (The latter seems less likely given the ongoing communication with program customers).

Customers were generally satisfied with installed retrofit measures recommended in the assessment report, as

Figure 33.

Figure 33: Home Efficiency Genie Retrofit Measure Satisfaction

	Very unsatisfied (1)	Somewhat unsatisfied (2)	Neither satisfied nor unsatisfied (3)	Somewhat satisfied (4)	Very satisfied (5)	Average Rating
How satisfied are you with the measures installed through the retrofit?	2*	0	1	5	14	4.32

*The two respondents who reported “very unsatisfied” on this question also reported “very likely” to recommend the program.

◆ **Energy savings is customers’ primary motivation from completing retrofits, but costs remain a barrier**

Of the 22 respondents who reported installing recommended retrofits, energy savings was the primary motivation (20 respondents), and improved comfort was the second most common motivation (13), as Figure 34 shows. Cost was the main barrier (11 of 22 respondents), although eight respondents said there were no barriers to completing the retrofits, seven reported that finding a contractor was a barrier, and four reported the amount of time the project would take, as shown in Figure 35. Other reported barriers included lack of motivation, and a lack of time for the homeowner to complete the retrofits themselves. One respondent also reported that they only completed some of the recommended retrofits due to the costs.

Separately, the program implementers also noted that the upfront cost of the home assessment and the inability to participate in other CPAU programs were barriers to participation for some customers, especially early on when the Genie program was replacing the previous program that had been free for customers. However, the implementers also reported that customers recognize the value they receive from the program for a relatively small upfront cost.

Figure 34: Home Efficiency Genie Retrofit Motivations

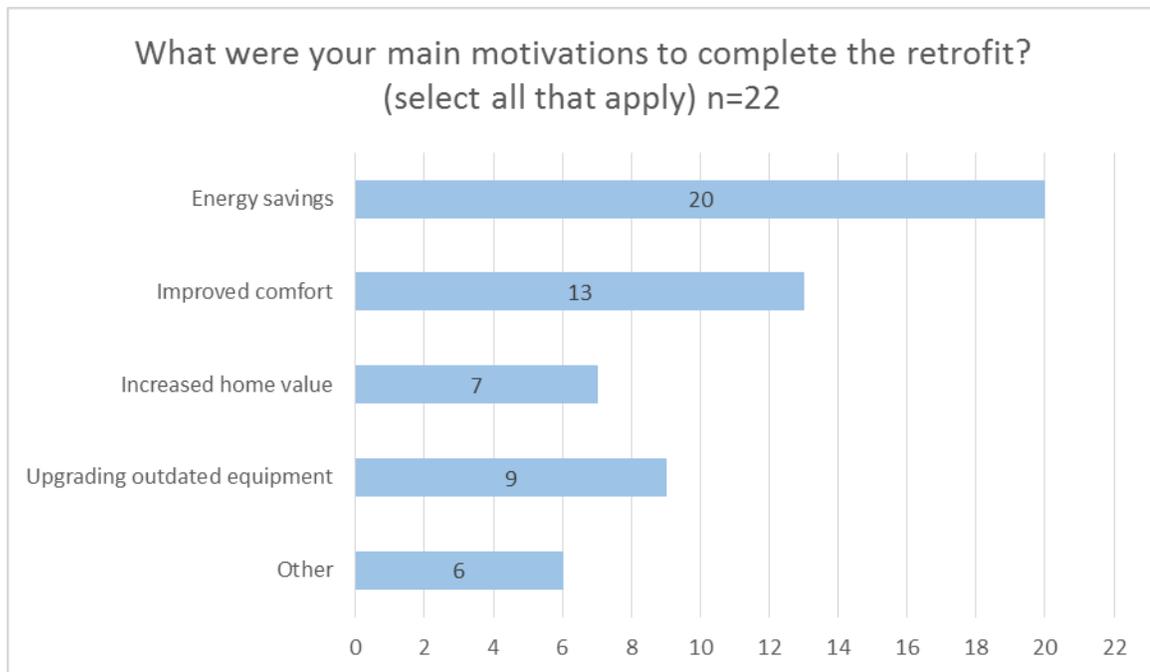
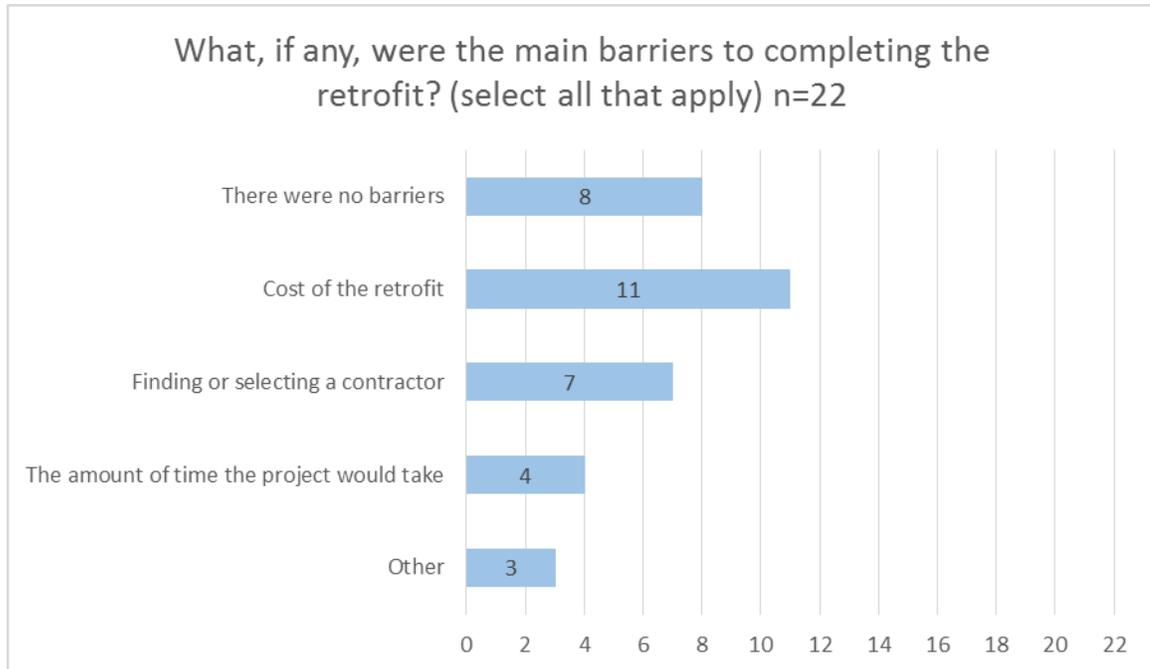


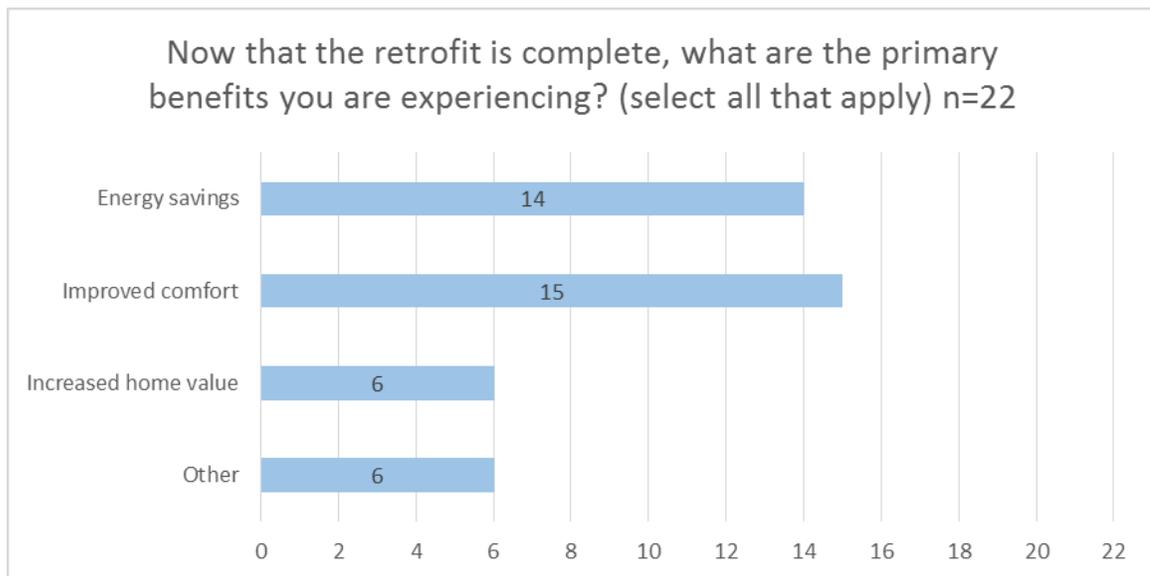
Figure 35: Home Efficiency Genie Retrofit Barriers



◆ **Improved comfort was the primary benefit reported, with energy savings a close second**

In terms of specific benefits of the retrofits, 15 respondents reported improved comfort, 14 reported energy savings, and six reported increased home values, as shown in Figure 36. Three respondents noted that the retrofits were ongoing or that they had been completed too recently to fully report on benefits. Other noted benefits were improved safety, lower energy bills, and wireless (“wifi”) control of HVAC.

Figure 36: Home Efficiency Genie Retrofit Benefits



◆ **Customers who had not yet completed retrofits were generally not likely to do so in the future**

Of the five respondents who had not yet completed retrofits, only one reported they were “very likely” to pursue retrofits in the next two years. Among the other respondents, one was “neither likely nor unlikely,” one was “somewhat unlikely,” one was “very unlikely,” and one did not respond. One respondent noted that their home did not need any retrofits.

However, because this is such a small subset of program participants, it is unclear whether these responses are representative of the other program customers who have not yet completed retrofits. As noted above, the program implementers reported that this type of program model requires a much longer timeframe for participating customers to complete retrofits.

◆ **Customers were generally happy with the ongoing communication from the program**

19 of 26 respondents reported they were “very satisfied” with the ongoing communication from the program (two were “somewhat satisfied,” four were “neither satisfied nor unsatisfied,” and one was “very unsatisfied,” though this respondent also reported “very likely to recommend the program”). Furthermore, 23 of 26 respondents rated the frequency of communication as “about right” (one said “somewhat too frequent,” one said “somewhat too infrequent,” and one said “far too infrequent”).

◆ **Most customers first heard about the program from bill inserts**

17 of 26 respondents reported that they first learned of the program through bill inserts. This result may simply be a reflection of the respondents being early participants, who learned about the program before additional advertising channels were in wide use. However, this result may also suggest that direct communication from the utility is the most effective channel for reaching potential participants, and the most trusted form of communication for those participants.

A review of data sources provided by the program also indicates that the vast majority (greater than 75%) of program leads come from some sort of direct communication with the utility, including bill inserts, email newsletters, and community or tabling events. Program implementers also indicated that targeting outreach efforts towards homeowners who are already planning home renovations or improvements could be especially effective.

◆ **Customers are generally likely to recommend the program to friends or neighbors**

18 of 26 respondents reported they are “very likely” to recommend the program, and another four respondents are “somewhat likely” to recommend it. This indicates that satisfied program participants could be a potentially valuable channel for identifying new program participants, if leveraged effectively.

◆ **Most respondents are aware that the Genie program is a resource for other home energy needs**

19 of 26 respondents were aware that the Genie program is also a resource for other home energy, water efficiency, renewable energy, and electric vehicle needs. However, survey respondents are likely to be the customers most engaged and most aware of program offerings, so these findings do not necessarily indicate widespread awareness of these program resources.

- ◆ **Open-ended suggestions for improving the program were limited, and generally reiterated earlier positive responses**

The last question of the survey asked if customers had any suggestions for improving the program. Only seven customers responded. Four of these customers provided positive feedback, indicating they had no suggestions, or were very happy with the service provided by the program. One customer expressed a negative view, questioning the value of the service (the same customer who has provided negative feedback on questions above). One customer suggested getting information on the program to a larger audience. In addition, one customer suggested recommending that customers use watt meters (potentially available through public libraries) to identify opportunities for reducing plug loads.

7.5 Conclusions and Recommendations

Overall, survey responses and implementer feedback indicate that customer response to the Home Efficiency Genie program has been positive, though participation at this early stage has been relatively low.

Based on the findings discussed above, TRC presents the following recommendations:

- ◆ **Continue direct customer outreach efforts.** Customers seem most responsive to direct contact from CPAU advertising the program, whether through direct mailing and bill inserts, or community and tabling events. TRC recommends that CPAU continue to focus on these direct communication efforts, with a focus on targeting audiences who are most likely to pursue home improvements (i.e., tabling at community events related to efficiency improvements and renewable energy, home improvement stores, etc.). Coordination with the city building department may also provide opportunities to inform homeowners who are already planning improvements about the program, or to identify potential program participants.
- ◆ **Consider opportunities to encourage and leverage word of mouth for customer recruitment.** Almost all customers are very or somewhat likely to recommend the program to friends and neighbors. TRC recommends that CPAU explore opportunities to leverage and encourage those recommendations, either through expanding current efforts like yard signs at participants' homes, or through new efforts such as referral bonuses or other incentives.
- ◆ **Consider opportunities to leverage other program offerings to encourage Genie customers to complete retrofits.** Although customers recognize the value provided by the program, the cost of completing the recommended retrofits remains a barrier. TRC recommends that CPAU explore opportunities to allow Genie participants to participate in other CPAU program offerings to encourage homeowners to complete the recommended retrofits, and capture the energy savings.
- ◆ **Consider increased emphasis on comfort improvements as an additional benefit of the program.** Although energy savings was customers' primary motivation in pursuing retrofits, improved comfort was the most often cited benefit of the retrofits (followed closely by energy savings). TRC recommends that the program provide additional emphasis on potential comfort improvements to help motivate customers to complete retrofit recommendations.
- ◆ **Continue tracking feedback from customers who do not complete retrofit measures to inform future program improvements.** Although only a handful of survey respondents reported that they did not plan to pursue the recommended retrofits and the program continues to follow-up with customers to provide support, understanding the motivations and barriers for these

customers could help improve how the program makes retrofit recommendations, and how the program targets customers for participation in the future.

8 CALCULATION OF NET AND LIFECYCLE SAVINGS

8.1 Net Savings

To calculate net savings, TRC multiplied the gross savings for each measure by the NTGR. TRC obtained the NTGR values for each measure from the Northern California Power Agency (NCPA) Energy Efficiency (EE) Reporting Tool based on the E3 calculator, which took NTGR values from DEER 2014. Based on this data source, TRC used a NTGR described below for each program.

To calculate net natural gas savings, TRC assumed the same NTGR for electricity (kWh) and natural gas (therms) calculations, as explained below:

- ◆ Although CPAU has historically assumed a 100% net-to-gross ratio (NTGR) for natural gas savings¹, all of the CIEEP (both Enovity and CIEEP Ecology Action) measures that produced natural gas savings also produced electricity savings. It is unknown whether the customer was motivated by electricity savings, gas savings, or a combination of both. For consistency, TRC assumed the kWh NTGR for calculating therm savings for CIEEP projects. TRC also assumed the electricity NTGR when calculating net therms due to lighting interactive effects in the CIEEP, EMPower, and MPP programs.
- ◆ The MPP included ceiling insulation projects installed in buildings with natural gas heating and no air conditioning. TRC assumed NTGR of 100% for ceiling insulation measures because:
 - These customers were only motivated by natural gas savings, since there was no air conditioning (kWh) savings. The DEER 2014 NTGR value for residential ceiling insulation (28%) is for both electricity and natural gas savings. DEER 2014 does not provide a NTGR for ceiling insulation measures that only provide natural gas savings. TRC believes the level of free ridership would be lower for customers that will only save natural gas, because there will be no reduction in electricity bills.
 - Anecdotal evidence from the two participants in the MPP survey that installed ceiling insulation found that they were motivated to participate because of energy bill savings, and that they would not have been willing to pay for any portion of the insulation measure (see section 10.3 for survey results).

8.1.1 Program NTGRs

For CIEEP- Enovity and CIEEP-Ecology Action, all measures were custom commercial projects, for which the NTGR is 80%. For consistency, TRC assumed the same NTGR for kWh and therm savings.

For EMPower, all measures were commercial lighting measures except for one refrigeration measure, both of which have a NTGR equal to 80%. TRC assumed the same NTGR for kWh and therm savings due to interactive effects. Because the therm savings were negative, the net-to-gross adjustment *increased* savings.

¹ The rationale is that natural gas equipment is typically capital intensive, and natural gas is relatively inexpensive. Both of these should decrease the likelihood that the participant would have installed the same equipment in the absence of the program, making free ridership very low or nonexistent. However, for FY 2016,

For MPP, the measures have a mix of NTGRs.

- ◆ For lighting measures installed in common nonresidential spaces and the exterior (generally parking garages), TRC assumed a NTGR equal to 80%;
- ◆ For lighting measures installed in residential units, TRC used the residential lighting NTGR equal to 54%;
- ◆ For ceiling insulation, TRC assumed the NTGR for residential ceiling insulation equal to 100%. Note this only affected therm savings.

For Net kWh Savings from MPP: TRC could not use a sampling approach to develop net savings for the program, because the program did not provide net savings at the project level. Instead, TRC developed a kWh-weighted average NTGR for the MPP as follows: For all sampled measures, TRC multiplied the NTGR of each measure by that measure's ex post kWh, and divided this by the total ex post kWh in the sample.

$$MPP\ NTGR = \frac{\sum_{\text{sampled measures}} (\text{measure kWh} \times \text{measure NTGR})}{\sum_{\text{sampled measures}} \text{measure kWh}} = 64\%$$

Note that this value represents the average NTGR for lighting measures, because only lighting measures contribute to electricity savings.

To extrapolate from sampled net savings values to program net savings, TRC multiplied the MPP NTGR by the total program gross savings.

$$MPP\ Net\ kWh = MPP\ Gross\ Savings \times MPP\ NTGR = 150,840\ kWh \times 64\% = 96,387\ kWh$$

For Net Therm Savings from MPP: Because the lighting and ceiling insulation measures have a different NTGR, TRC used the following approach. TRC:

- ◆ Calculated the realization rate for the program if interactive effects had *not* been included, by assuming 0 therms for lighting projects; the result was 15,558 therms. The difference in program savings with interactive effects: 10,777 therms, and without interactive effects: 15,558 therms, represented the negative therm savings from lighting measures: -4,781 therms. TRC applied the average kWh NTGR found for lighting (64%, as shown above) to calculate -3,060 net therms from lighting measures.
- ◆ Applied the 100% NTGR to gross savings from ceiling insulation: 15,558 therms
- ◆ Added the lighting and ceiling measure savings (-3,060 + 15,558 therms) to calculate 12,498 total net therms.

Note that the net therms is *higher* than the gross therms for MPP. This is because there is only a net-to-gross adjustment to the therm savings from lighting measures; because these are negative savings, the adjustment reduces the negative value.

For the HER program, TRC assumed NTGR equal to 100% (per the E3 Calculator Reporting Tool). As described in Section 4.2, TRC developed savings fractions based on *net* savings compared to a control group and applied them to the energy use to calculate HER savings. Therefore net savings are calculated directly and there is no NTGR estimate. Consequently, TRC assumed the same value for gross savings as net savings. While this method underestimates gross savings, it is the most conservative method without a reliable estimate of NTGR.

8.1.2 Portfolio-level Net Savings Results

Figure 37 provides program level net annual savings results. The gross and net natural gas savings values in Figure 37 include interactive effects. Programs for which TRC conducted an impact evaluation are shown with an asterisk (*). For programs not evaluated in FY2016, Figure 16 shows ex ante net savings (i.e., TRC did not make adjustments to net savings). This figure does not include programs with zero savings (CIEEP –BASE, SCVWD, ERS, and Res New Construction).

- ◆ For the CIEEP-Enovity, CIEEP-Ecology Action, EMPower, and HER programs, TRC’s adjustments to net kWh savings for these programs resulted from adjustment to gross savings. For the MPP, TRC’s calculation of a program weighted-average NTGR (64%) is similar to the program-weighted average calculate using ex ante savings values (60%), so the majority of adjustments to MPP net savings are also due to gross savings adjustments, rather than different assumptions of NTGRs.
- ◆ Because TRC conducted a process evaluation, rather than an impact evaluation, for the Home Efficiency Genie program, we did not calculate a NTGR for this program. The net savings shown in Figure 37 for the Home Efficiency Genie program are ex ante savings. The NTGR for Home Efficiency Genie program (42%) is low; however, most of the residential measures installed through the program have low NTGRs¹, so this overall NTGR for the program is reasonable.

¹ Measures installed through the program and their corresponding NTGRs include residential lighting- 54%, faucet aerators – 60%, ceiling insulation – 28%, and duct sealing – 80%.

Figure 37. Net Annual Savings

CPAU Program	Ex Post Gross			Ex Post Net			
	Demand (kW)	Energy Savings (kWh)	Natural Gas (Therms)	NTGR	Peak Savings (kW)	Energy Savings (kWh)	Natural Gas (Therms)
COM-CIEEP - Ecol Action*	268	1,994,193	92	80%	215	1,595,355	73
COM-CIEEP - Enovity*	74	1,932,921	115,994	80%	59	1,546,337	92,795
RES-Home Energy Report*	0	1,386,987	135,779	100%	0	1,386,987	135,779
COM-EMPower*	76	423,861	(2,300)	80%	61	339,089	(1,840)
COM-Commercial Advantage	0	418,306	4,430	80%	0	334,645	3,544
RES-MultiFamilyPlus*	15	150,840	10,777	64%	10	96,387	12,498
RES-Smart Energy	0	81,540	4,046	60%	0	48,564	2,409
COM-Gen T&D	8	70,460	-	100%	8	70,460	-
RES-REAP Low Income	0	28,633	4,451	80%	0	22,907	3,561
COM-Business New Construction	0	28,556	-	85%	0	24,273	-
RES-Home Efficiency Genie	0	8,400	2,484	42%	0	3,513	1,039
Total	441	6,524,697	275,751	84%	352	5,468,516	249,858

* Programs for which TRC conducted an impact evaluation in FY2016.

**The NTGR shown is for electricity savings. NTGR for natural gas savings was 116%. The NTGR is over 100%, because the measure providing positive therm savings (ceiling insulation) had a NTGR equal to 100%, while the measure providing negative therm savings (lighting projects through interactive effects) had a NTGR of 64%. Applying the NTGR therefore reduced only the negative therms.

8.2 Lifecycle Savings

This section describes the methodology used to calculate ex post lifecycle savings. We begin by describing our EUL assumptions, and then describe how we calculated measure-level, project-level, and program level lifecycle savings.

8.2.1 Effective Useful Life (EUL) Assumptions

For all measures, TRC used the TRM assumptions to identify the effective useful life (EUL) where possible. If the TRM did not provide a measure-specific EUL, TRC used DEER 2014 values.

For some lighting measures, the TRM provided a range for the EUL. In particular, the TRM provides the EUL for LED lamps and fixtures as, "Range of 5–15 years (rated fixture or lamp life divided by annual operating hours for each building type)."¹ For these measures, TRC used the rated life from DEER 2014 and divided it by the assumed operating hours for the particular building type. For example, for an LED lamp installed in a small retail store (DEER operating hours 3,380 hours per year, and measure life equal

¹ TRM section 6.4, "LED Lighting", p. 6-6.

to 20,000 hours), TRC calculated an EUL of 5.9 years, while the program assumed a lifetime of 15 years. TRC's adjustment to lighting EUL based on operating hours aligns with TRM guidance.

For controls projects, TRC assumed an EUL equal to one year, following current CPAU policy.

8.2.2 Lifecycle Savings Calculations

TRC began by calculating lifecycle savings at the measure level, then the project-level, and then the program-level, as described below.

Measure level: TRC calculated lifecycle savings by multiplying annual savings by the EUL for each measure.

Project level: For single-measure projects, project-level savings equaled measure-level savings, by definition.

For projects with multiple measures, TRC calculated a project measure life based on a weighted average, where the EUL of each measure was weighted by the annual savings of that measure.

$$\text{Project measure life} = \frac{\sum_{\text{measures in project}} [\text{measure ex post kWh} \times \text{measure EUL}]}{\sum_{\text{measure in project}} [\text{measure ex post kWh}]}$$

TRC then multiplied the project measure life by the annual savings to estimate project lifecycle savings.

Program level: For the CIEEP program, TRC summed the lifecycle savings across all projects for the program total lifecycle savings.¹

For programs where TRC conducted sampling (EMPower and MPP), TRC applied sampling weights to the project-level lifecycle kWh results to develop a program level realization rate for lifecycle kWh. TRC multiplied the program ex ante lifecycle kWh total by the lifecycle kWh realization rate to determine ex post lifecycle kWh.

8.2.3 Summary of Lifecycle Savings and Adjustments

Figure 38 provides the program-average EUL, and each program's lifecycle savings results. The differences between ex ante and ex post realization rates were primarily because TRC calculated measure-specific EUL values for lighting measures (based on operating hours and measure life). The CIEEP-EA and EMPower programs assumed the maximum measure life (15 years). The MPP may have also assumed the maximum measure life, although TRC cannot confirm this assumption due to the lack of supporting calculations. In addition, TRC's reductions to annual kWh savings reduced lifecycle kWh savings.

Figure 38 provides program level net lifecycle savings results. Programs for which TRC conducted an impact evaluation are shown with an asterisk (*). For programs not evaluated in FY2016, Figure 38 shows ex ante lifecycle savings (i.e., TRC did not make adjustments to lifecycle savings). Figure 38 does not include programs with zero savings (CIEEP –BASE, SCVWD, ERS, and Res New Construction).

¹ There were a few CIEEP-Enovity controls projects that TRC was not able to verify the claimed energy savings. TRC developed annual kWh savings for these projects by applying a realization rate based on the other CIEEP-Enovity controls projects (as described in Section 3). Because these projects were controls project, TRC multiplied the annual kWh savings by one year to calculate lifecycle savings.

Figure 38. Gross and Net Lifecycle Energy Savings

CPAU Program	Ex Ante Lifecycle		Input Values for Ex Post Lifecycle		Ex Post Lifecycle		
	Gross Savings (kWh)	Net Savings (kWh)	Ex Post Annual Gross Savings (kWh)	Average Measure Life (Yr)	Gross Savings (kWh)	Net Savings (kWh)	Gross Realization Rate (%)
COM-CIEEP - Ecol Action*	22,932,235	18,345,788	1,994,193	7.5	15,009,974	12,007,979	65%
COM-CIEEP - Enovity*	4,409,633	3,527,706	1,932,921	2.2	4,252,931	3,402,345	96%
RES-Home Energy Report*	1,283,418	1,283,418	1,386,987	1.0	1,386,987	1,386,987	108%
COM-EMPower*	6,927,045	5,541,636	423,861	5.6	2,354,837	1,883,869	34%
COM-Commercial Advantage	6,274,590	5,019,672	418,306	N.E.	6,274,590	5,019,672	N.E.
RES-MultiFamilyPlus*	2,460,068	1,283,178	150,840	9.9	1,497,575	956,950	61%
RES-Smart Energy	767,180	357,133	81,540	N.E.	767,180	357,133	N.E.
COM-Gen T&D	3,523,000	3,523,000	70,460	N.E.	3,523,000	3,523,000	N.E.
RES-REAP Low Income	277,911	222,329	28,633	N.E.	277,911	222,329	N.E.
COM-Business New Construction	428,340	364,089	28,556	N.E.	428,340	364,089	N.E.
RES-Home Efficiency Genie	145,534	57,656	8,400	N.E.	145,534	57,656	N.E.
Total	49,428,954	39,525,606	6,524,697	4.2	35,918,858	29,182,010	73%

* Programs for which TRC conducted an impact evaluation in FY2016.

N.E. = Not Evaluated

9 PROGRAM RECOMMENDATIONS

In general, the CPAU FY 2016 programs were successful in providing energy, demand, and natural gas savings to CPAU customers. TRC's evaluated savings were generally similar to the ex ante savings for each program, particularly for the programs with high savings.

However, TRC identified opportunities for improvement for the programs for which we conducted impact evaluations. While it was beyond our scope to provide a comprehensive set of recommendations (such as those developed through a process evaluation), TRC provides the following recommendations based on the EM&V results.

For all programs, TRC recommends that CPAU require that calculations follow consistent treatment of interactive effects. TRC recommends that CPAU programs include interactive effects for all calculations, and that third party implementers calculate the natural gas (i.e., negative therm) savings from lighting and refrigeration measures. Alternatively, if CPAU chooses to set policy that ignores interactive effects, programs should only include direct electricity and demand savings from lighting and appliances – not kW and kWh factors that include interactive effects.

9.1 CIEEP

TRC notes that this program includes a greater diversity in project type for FY2016 when multiple implementers delivered the program, compared with FY2015 when just one implementer delivered the program. Enovity delivered controls and equipment upgrade projects, while the majority of Ecology Action savings were from lighting projects with additional savings from controls projects. Consequently, this expansion of the program likely resulted in increased savings.

There were multiple CIEEP projects where the operating conditions at the time of TRC's verification did not match ex ante assumptions. As recommended by TRC for FY2015, in order to maintain persistence for energy savings from projects, the program should consider requiring commissioning or acceptance testing to verify that the equipment is at least installed and operating initially as designed/planned. CPAU could also consider requiring that the site provide follow-up trend data six to twelve months after project completion. CPAU technical staff or a trained 3rd party should review the trend data to ensure that the installed measures are operating as expected, and notify the customer and (if appropriate) the contractor that installed the equipment if it is not operating properly.

A recent CPUC ruling¹ identified the EUL for retro-commissioning and operational projects as three years. The ruling does not specify requirements to claim this persistence of three years, beyond normal persistence requirements for all measures. Based on TRC's experience with IOU programs, persistence requirements for retro-commissioning projects typically are not rigorous – e.g., a training meeting at the completion of implementation of the project or requiring a maintenance contract that covers the affected system. If CPAU wishes to align with CPUC policy and claim three years for controls projects, TRC recommends that CPAU include more follow-up to ensure that these savings actually persist. For example, the in-house training or maintenance contract should include language that explicitly governs the equipment affected by the controls project, to reduce the likelihood that these controls will be changed. The implementer could also include training for monitoring the same trends used for the

¹ CPUC's Final Decision (16-08-019) of Rulemaking 13-11-005

original savings calculations. For example, the implementer could set up graphs and an input file based on the operating conditions at the time of project implementation, and show facility personnel how to paste in new data to update the trend graphs. In addition to checking for persistence, this periodic review of equipment operation can also help the customer identify equipment malfunctions or inadvertent controls adjustments. In addition, CPAU should periodically (e.g., annually or bi-annually) check that the controlled equipment is still in operation, and conduct on-site metering or a review of trend data to check that set points align with savings assumptions. If the site-level recommendation above is followed and the participants periodically update trend graphs with new operating data, CPAU staff, such as key account representatives, could review these graphs and verify that savings are persisting.

Ecology Action implemented several lighting projects through the program. For lighting projects, the implementer should use baseline wattages that comply with current state and federal regulations. In addition, the implementer should include coincident demand factors to properly account for demand savings. TRC notes that the implementer did calculate project-specific EULs for their lighting projects. However, CPAU staff did not enter the project-specific EULs when calculating the lifecycle savings, but instead used default values (e.g., e.g., 15 years for LEDs, 10 years for T8 replacements). In the future, CPAU staff should enter the project-specific EUL to increase lifecycle realization rates.

9.2 EMPower

The EMPower program claimed actual lighting operating hours for the facility, rather than deemed hours, and used a customer signed affidavit to document the lighting operating hours. In several of the projects, these lighting operation hours exceeded the hours for which these facilities were open. While some lighting may be used before and after facility operation for stocking, cleaning, maintenance, or other tasks, the hours for these tasks are difficult to verify, and facilities may run the lighting at partial loads.

TRC recommends that CPAU establish more rigorous requirements to document lighting operation, such as light metering data. Otherwise, TRC recommends that the EMPower program use facility operating hours for interior lighting, and DEER assumptions for operating hours for exterior lighting, since these may be different from the facility operating hours and are often subject to photo-sensing controls.

In addition, TRC recommends that the implementer:

- ◆ Use lamp wattages that comply with current regulations for LED replacements, and
- ◆ Calculate project-specific EUL values for lighting measures and provide these to the program for lifecycle savings calculations.

CPAU staff should use the project-specific EULs for lighting measures (rather than default values) when calculating lifecycle savings.

9.3 Multifamily Plus Program

TRC noted that the quality of measure installation appears to be good. For example, based on our on-site verifications, the implementer replaced all lighting in an area. For ceiling insulation, the implementer installed a uniform depth of blown-in insulation. In addition, the MPP participant survey found fairly high satisfaction with the program, and the three survey respondents all reported high likelihood of participating in the program again or recommending it to a peer. However, TRC recommends that the implementer significantly improve the documentation of measures installed and savings calculations. Specifically:

- ◆ For all measures, the implementer should submit project-specific savings calculations for electricity, demand, and natural gas savings so that the evaluator can identify the source of discrepancies between ex ante and ex post results. The implementer currently submits such calculations for insulation projects, but not lighting projects.
- ◆ Similar to EMPower, the implementer should use lamp wattages that comply with current regulations for LED replacements, and calculate measure-specific EUL values for lighting measures and provide these to the program for lifecycle savings calculations.
- ◆ For ceiling measures, the implementer should only assume square footage over conditioned space. In addition, the implementer should take pictures of the existing condition. TRC used vintage tables to estimate existing condition, but photographs are more reliable. Finally, the implementer should only claim electricity savings for ceiling measures installed in buildings with air conditioning.
- ◆ The implementer should obtain email addresses for all participants, so that the program can conduct follow up research, such as electronic surveys to gather participant feedback. TRC was unable to administer the survey to most participants, because the program database contained only a few participants' email addresses.
- ◆ The implementer should improve its database tracking and reporting so that the total program savings values are supported by the project level savings in the program database.

The CPAU program manager should increase his/her quality assurance to ensure that the above recommendations are followed. In addition, CPAU staff should use the project-specific EULs for lighting measures (rather than default values) when calculating lifecycle savings.

9.4 Home Energy Report Program

HER is the largest residential program (for kWh and therm savings) and a major savings program in general for the CPAU portfolio. If this program continues to be inactive, HER savings will continue to decline by 20% each year as persistence declines. TRC recommends that CPAU conduct research into how other utilities have handled long-running HER programs (e.g., sending reports less frequently for customers that have been in long-term treatment) and the resulting savings from these strategies. In addition, CPAU should investigate other residential behavioral program designs. For example, San Diego Gas and Electric has offered a "Manage-Act-Save" program that offers prizes for energy reduction, in addition to neighbor comparison reports.

9.5 Home Efficiency Genie Program

Based on the results of the process evaluation – particularly the participant survey – TRC provides the following recommendations. Section 7.5 provides more detail on each recommendation.

- ◆ Continue direct customer outreach efforts.
- ◆ Consider opportunities to encourage and leverage word of mouth for customer recruitment.
- ◆ Consider opportunities to leverage other program offerings to encourage Genie customers to complete retrofits.
- ◆ Consider increased emphasis on comfort improvements as an additional benefit of the program.
- ◆ Continue tracking feedback from customers who do not complete retrofit measures to inform future program improvements.

10 APPENDICES

This section includes the following appendices:

1. The rationale for why CPAU and TRC selected CIEEP, HER, EMPower, MPP, and Home Efficiency Genie for FY 2016 evaluation instead of other CPAU programs.
2. The electronic survey guide for the Home Efficiency Genie program.
3. The electronic survey guide and survey results for the MPP.

10.1 Rationale for Selecting Programs for FY 2016 Evaluation

Figure 39 presents each program in the CPAU FY 2016 portfolio, its ex ante electricity (kWh) savings, whether the program was evaluated the previous year (FY2015), the EM&V prioritization, whether or not the program was ultimately selected for FY 2016 evaluation, and the final rationale for this decision.

Figure 39. FY 2016 EM&V Program Selection

Program	Ex Ante Electricity (kWh)	Evaluated in FY2015?	EM&V Priority	Evaluated in FY2016?	Rationale for Evaluating / Not Evaluating Program
CIEEP	4,167,805	Yes	High	Yes	Program with highest ex ante savings and added new implementer
Home Energy Report	1,283,418	No	Medium	Yes	Emphasis on persistence savings
EMPower	465,747	Yes*	Medium	Yes	Replaces RightLights (* evaluated in FY15), adding non-lighting measures
Multifamily	177,249	No	Medium	Yes	Mid-point evaluation based on adding new measures
Home Efficiency Genie	8,400	N/A	Medium	Yes	New program, process evaluation only
Commercial Advantage Program (CAP)	418,306	Yes	Low	No	Low savings
Smart Energy	81,540	No	Low	No	Low savings
General T&D	70,460	No	Low	No	Low savings
REAP Low Income	28,633	No	Low	No	Low savings
Business New Construction	28,556	Yes	Low	No	Low savings
Residential New Construction	0	No	Low	No	No Savings
Santa Clara Valley Water District (SCVWD)	0	No	Low	No	No Savings

10.2 Home Efficiency Genie Program Interview and Survey Guides

The sections below outline the interview and survey guides for the Home Efficiency Genie Program process evaluation.

10.2.1 Program Manager Interview Guide

The following questions provided an overall guide to the program manager interview, but the conversation was not limited to these topics.

- ◆ What kinds of insights or information are you hoping to get from the evaluation?
- ◆ How do you define success for the program?
- ◆ What do you see as the main challenges for the program?
- ◆ Do you have any plans or suggestions for improving the program?

10.2.2 Program Implementer Interview Guide

The following questions provided an overall guide to the program implementer interview, but the conversation was not limited to these topics.

- ◆ What initial insights can you share with me about your experience with the program, and your role in it?
- ◆ How would you define success for the program? (Have you achieved that success, or are you on your way to achieving it?)
- ◆ What are the main challenges for the program? (Any challenges in start-up, or in transitioning from the previous program?)
- ◆ How have customers responded to the program?
- ◆ Are there aspects of the program that customers find more helpful than others?
- ◆ What kinds of barriers have customers cited for not pursuing home audits, or retrofit projects?
- ◆ Do you have any suggestions or plans for improving the program? (Are any of these in action?)
- ◆ Are there any specific insights or information you would like the evaluation to explore?

10.2.3 Online Customer Survey Guide

1. How satisfied were you with the home assessment you received through the Home Efficiency Genie program?
 - a. Very unsatisfied
 - b. Somewhat unsatisfied
 - c. Neither satisfied nor unsatisfied
 - d. Somewhat satisfied
 - e. Very satisfied

Do you have any comments about the home assessment? (optional, open ended)

2. How satisfied are you with the instant savings measures installed as part of the home assessment (energy efficient light bulbs and faucet aerators)?

- a. Very unsatisfied
- b. Somewhat unsatisfied
- c. Neither satisfied nor unsatisfied
- d. Somewhat satisfied
- e. Very satisfied

Do you have any comments about the instant savings measures? (optional, open ended)

3. How satisfied were you with the report you received following the home assessment?

- a. Very unsatisfied
- b. Somewhat unsatisfied
- c. Neither satisfied nor unsatisfied
- d. Somewhat satisfied
- e. Very satisfied

Do you have any comments about the home assessment report? (optional, open ended)

4. Have you completed any of the recommended retrofits from your home assessment?

- a. Yes
- b. No

5. (if yes on 4) How much influence did the home assessment have on your decision to complete that retrofit?

- a. Not influential at all
- b. Not very influential
- c. Somewhat influential
- d. Very influential
- e. Completely influential

6. (if yes on 4) How satisfied are you with the measures installed through the retrofit?

- a. Very unsatisfied
- b. Somewhat unsatisfied
- c. Neither satisfied nor unsatisfied
- d. Somewhat satisfied
- e. Very satisfied

7. (if yes on 4) What were your main motivations to complete the retrofit? (select all that apply)

- a. Energy savings
- b. Improved comfort

- c. Increased home value
 - d. Upgrading outdated equipment
 - e. Other (please specify)
8. (if yes on 4) What, if any, were the main barriers to completing the retrofit? (select all that apply)
- a. There were no barriers to completing the retrofit
 - b. Cost of the retrofit
 - c. Finding or selecting a contractor to do the work
 - d. The amount of time the project would take to complete
 - e. Other (please specify)
9. (if yes on 4) Now that the retrofit is complete, what are the primary benefits you are experiencing? (select all that apply)
- a. Energy savings
 - b. Improved comfort
 - c. Increased home value
 - d. Other (please specify)
10. (if no on 4) How likely are you to complete any of the recommended retrofits within the next 2 years?
- a. Very unlikely
 - b. Somewhat unlikely
 - c. Neither likely nor unlikely
 - d. Somewhat likely
 - e. Very likely
11. (if no on 4) How much influence did the home assessment have on these future retrofit plans?
- a. Not influential at all
 - b. Not very influential
 - c. Somewhat influential
 - d. Very influential
 - e. Completely influential
12. (if no on 4) What would be your primary motivation for pursuing the recommended retrofits? (select all that apply)
- a. I do not plan on pursuing any retrofits
 - b. Energy savings
 - c. Improved comfort

- d. Increased home value
 - e. Upgrading outdated equipment
 - f. Other (please specify)
13. (if no on 4) What, if any, are the primary barriers to completing the recommended retrofits? (select all that apply)
- a. There are no barriers to completing the retrofits
 - b. Cost of retrofits
 - c. Challenges finding or selecting a contractor to do the work
 - d. The amount of time the project would take to complete
 - e. Other (please specify)
14. How satisfied are you with the ongoing support you receive from the Genie program?
- a. Very unsatisfied
 - b. Somewhat unsatisfied
 - c. Neither satisfied nor unsatisfied
 - d. Somewhat satisfied
 - e. Very satisfied
15. Would you say the frequency of the follow-up contact from the Genie program is:
- a. Far too frequent
 - b. Somewhat too frequent
 - c. About right
 - d. Somewhat too infrequent
 - e. Far too infrequent
16. How did you first hear about the Genie program?
- a. Bill insert
 - b. Online advertisement
 - c. Social media (i.e., Facebook, etc.)
 - d. Word of mouth
 - e. Saw program vehicle in my neighborhood
 - f. Other (please specify)
17. How likely are you to recommend the Home Efficiency Genie program to your neighbors?
- a. Very unlikely
 - b. Somewhat unlikely
 - c. Neither likely nor unlikely

- d. Somewhat likely
- e. Very likely

How would you describe the Home Efficiency Genie program to your neighbors? (optional, open ended)

18. Are you aware that the Home Efficiency Genie program is a resource for your other home energy, water efficiency, renewable energy and electric vehicle needs?

- a. Yes
- b. No

19. Do you have any suggestions for improving the Home Efficiency Genie program? (open ended)

10.3 MPP Participant Survey Results

To inform program improvement, and to better understand participants' motivations, TRC developed a survey for MPP participants. Because the program database only included email addresses for a few participants, TRC could only administer the survey to a select number of participants. TRC worked with the program staff and implementer to send a survey invitation to ten participants, including the five participants that TRC worked with to coordinate site visits, and five participants for which the program database had an email address. (For the remaining participants, the program database did not have an email address.) A total of three participants responded to the survey.

TRC emphasizes that these results are anecdotal, given the small number of responses. However, the results provide some preliminary indications of participant motivation and satisfaction.

Section 10.3.1 presents the full survey guide, followed by the results in Section 10.3.2.

10.3.1 MPP Participant Survey Guide

The following survey was administered in Survey Monkey in January – February 2017.

Introduction

The City of Palo Alto Utilities is seeking input from Multifamily Plus Program participants to improve this program. As a former program participant, we greatly appreciate your feedback! Please forward the survey link if someone else is better suited to respond to this survey.

This survey has 3 sections and asks questions regarding program benefits; satisfaction with the energy saving measures installed and purchasing decisions; and overall program satisfaction and recommendations. It takes approximately 10 minutes. All answers are anonymous. Thank you so much for your time.

This survey was developed by an independent consultant: TRC Energy Services. Please direct any questions or concerns regarding this survey to Marian Goebes: MGoebes@Trcsolutions.com, (916) 844-0134, or to the CPAU Multifamily Plus Program Manager: [withheld in report for confidentiality]

Background and Program Benefits

Q1. How would you best describe your role for the building(s) that participated in the Multifamily Plus Program?

- Owner
- Facility manager
- Property or rental manager
- Other. Please specify

Q2. For the building(s) that participated, are the multifamily units mostly market rate, affordable housing, or a mix of both?

- Mostly market rate
- Mostly affordable housing
- Mixed – specify what percent of each

Q3. Approximately how large is the multifamily property(s) that participated? If the property has more than 1 building, total the number of units across all buildings.

- Small: <10 units per property
- Medium: 10-50 units per property
- Large: >50 units per property

Q4. How did you first learn about the Multifamily Plus program?

- Personal visit from program representative
- Mail insert
- Phone call
- Email from program
- Referral (not from program representative)

Q5. In your opinion, what are the benefits of the Multifamily Plus program? Select all that apply.

- Lower energy bills
- Improved safety
- Improved light quality
- Increased comfort

Q6. Of those, which do you view as the **most important** program benefit?

- Lower energy bills
- Improved safety
- Improved light quality
- Increased comfort

Energy Efficiency Measures

Q7. What energy savings measures were installed at your multifamily building(s) through the program? Select all that apply.

- T8 linear fluorescent lighting
- LED lights
- Attic insulation

Q8. On a scale of 1 to 5, with 1 being very unsatisfied and 5 being very satisfied, how satisfied were you with the energy savings measures installed through the program?

- 1

- 2
- 3
- 4
- 5
- Don't know

Q9. Please provide any feedback (e.g. from you, the facility manager, or your tenants) regarding satisfaction (or dissatisfaction) with the measures installed. Be sure to note which energy efficiency measure (e.g. T8, LED, attic insulation) you are describing.

Q10. Would you have installed these energy savings measures if the program required that you pay a portion of the cost for the equipment?

- Yes
- No
- Maybe
- Only for some measures (please specify which measures):

Q11. What portion would you be willing to pay?

- None (0%)
- About one-fourth (1/4)
- About half (1/2)
- About three-fourths (3/4)
- All (100%)

Q12. Based on your experience with the lighting installed through the program, will you continue to buy similar lighting products for this or other multifamily buildings you manage?

- Not Applicable: No lights installed
- Yes
- No

Overall Program Satisfaction and Closing

Q13. On a scale of 1 to 5, with 1 being very unsatisfied and 5 being very satisfied, please rate your overall satisfaction with the program.

- 1
- 2
- 3
- 4
- 5

Q14. On a scale of 1 to 5, with 1 being very unlikely and 5 being very likely, how likely would you be to participate in the program with another building?

- 1
- 2
- 3
- 4

- 5
- Not Applicable: I don't manage or own other multifamily buildings in Palo Alto.

Q15. On a scale of 1 to 5, with 1 being very unlikely and 5 being very likely, how likely would you be to recommend this program to other multifamily property owners or managers?

- 1
- 2
- 3
- 4
- 5

Q16. Please provide any comments or suggestions for improving the program:

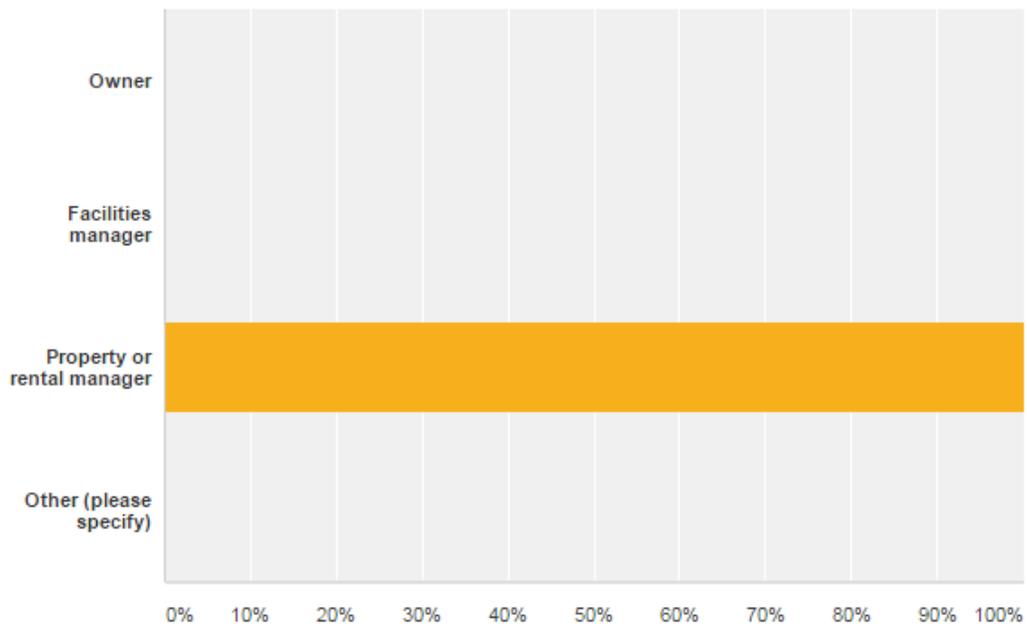
10.3.2 Survey Results

The following is a summary of survey results. Note that none of the respondents provided an answer to the open-ended questions, Q9 and Q16.

All survey respondents were property managers, and they represented a mix of multifamily building size and type (market rate and affordable). Although the survey allowed respondents to check owners or facility managers, all three reported to be rental or property managers. Two served primarily market rate multifamily buildings, while the third served primarily affordable units. The respondents represented a mix of multifamily building sizes.

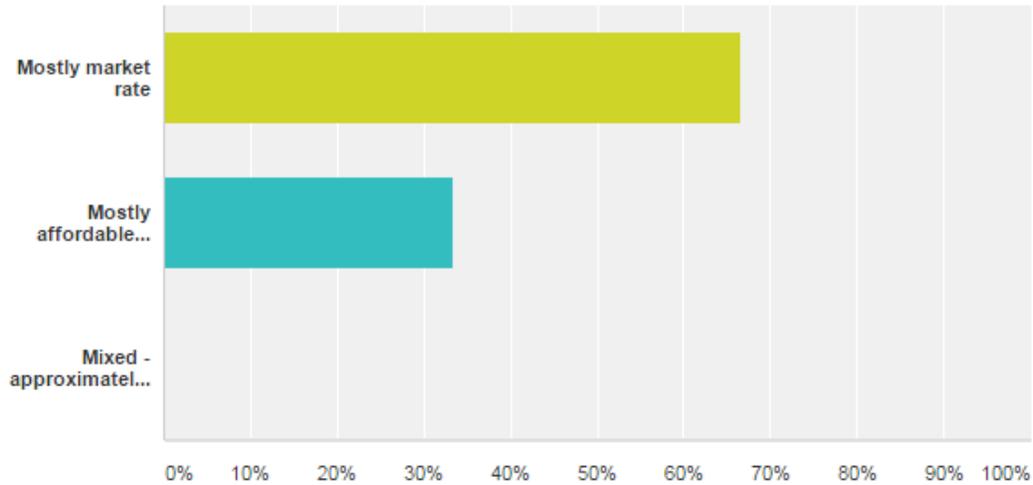
How would you best describe your role for the building(s) that participated in the Multifamily Plus Program?

Answered: 3 Skipped: 0



For the building(s) that participated, are the multifamily units mostly market rate, affordable housing, or a mix of both?

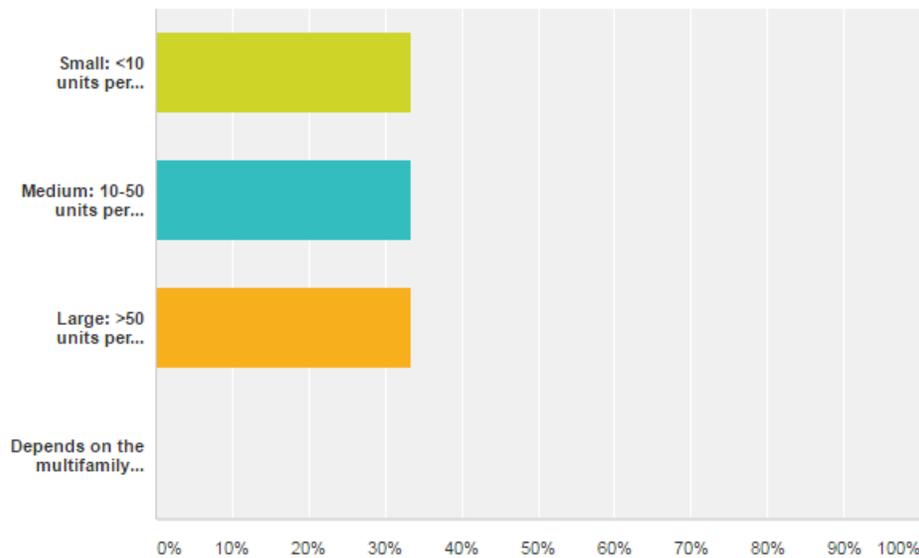
Answered: 3 Skipped: 0



For the question below, response options were: Small: <10 units per property; Medium: 10-50 units per property; Large: > 50 units per property; or Depends on the multifamily property.

Approximately how large is the multifamily property(s) that participated? If the property has more than 1 building, total the number of units across all buildings.

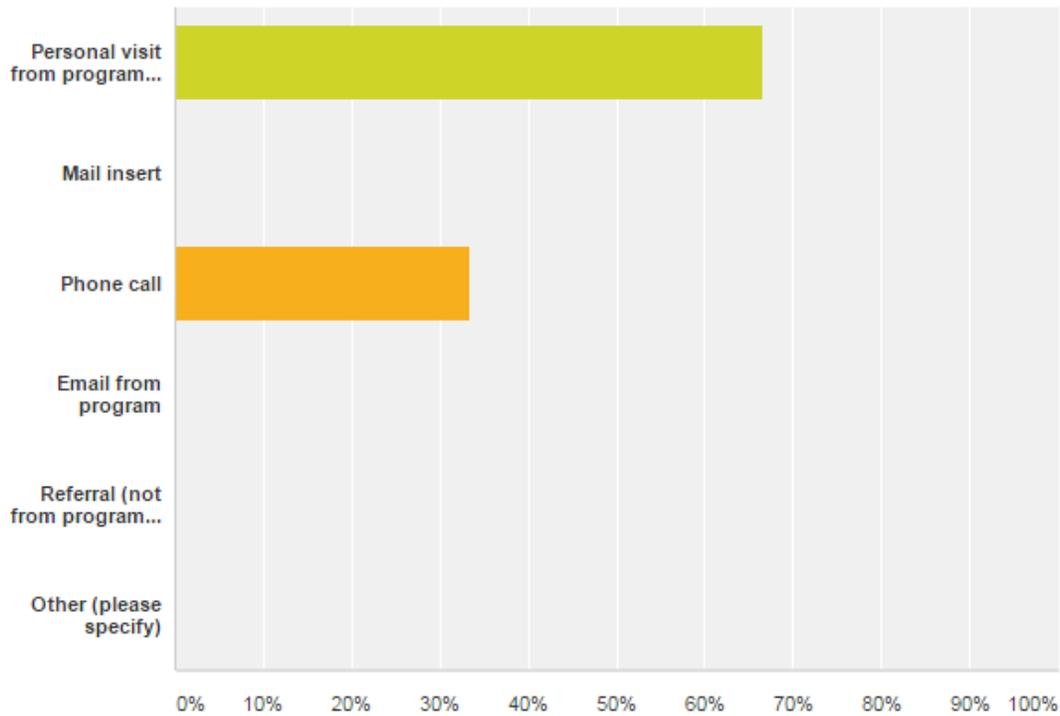
Answered: 3 Skipped: 0



These participants learned about MPP from contacts from a program representative. Two received a personal visit from a program representative, while the third received a phone call. This agrees with the marketing strategy reported by the implementer, which includes stopping by multifamily buildings in CPAU territory and speaking with facility staff about the program.

How did you first learn about the Multifamily Plus program?

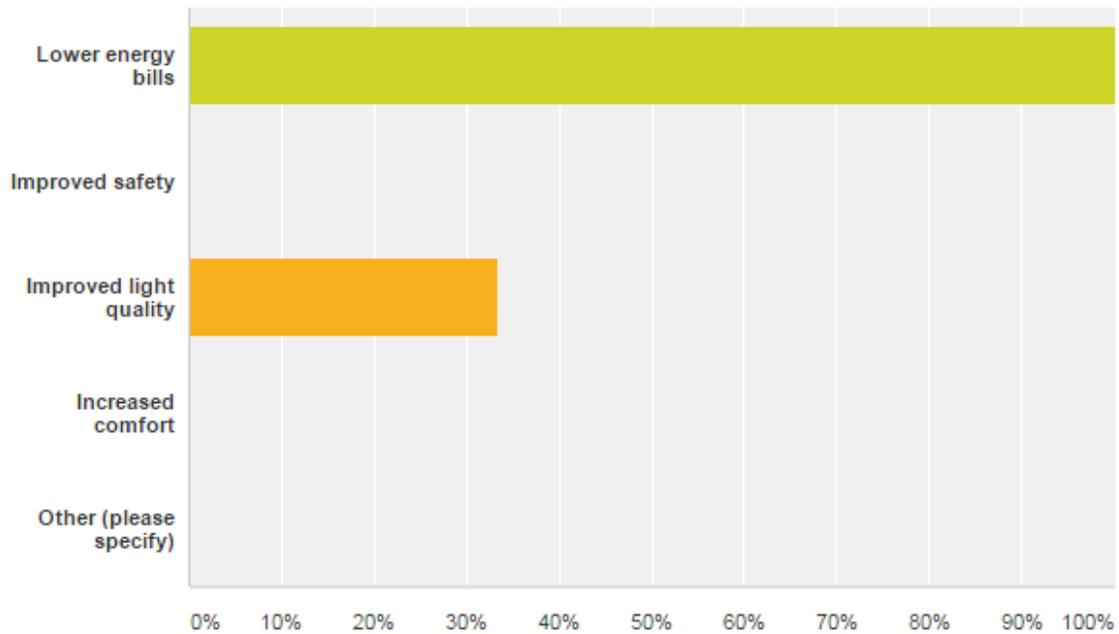
Answered: 3 Skipped: 0



Lower energy bills motivated the two participants that installed ceiling insulation, while improved light quality was the primary motivator for the participant that installed lighting. When allowed to select more than one benefit, all three participants selected “lower energy bills”, and the lighting participant selected “improved light quality”. When asked to identify the primary benefit, the lighting participant selected “improved light quality”.

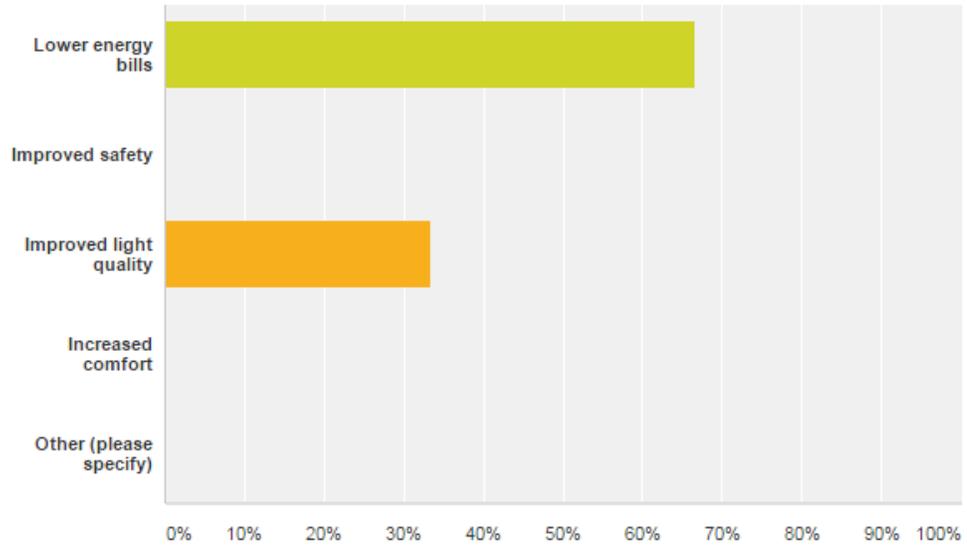
In your opinion, what are the benefits of the Multifamily Plus program? Select all that apply.

Answered: 3 Skipped: 0



Of those, which do you view as the most important program benefit?

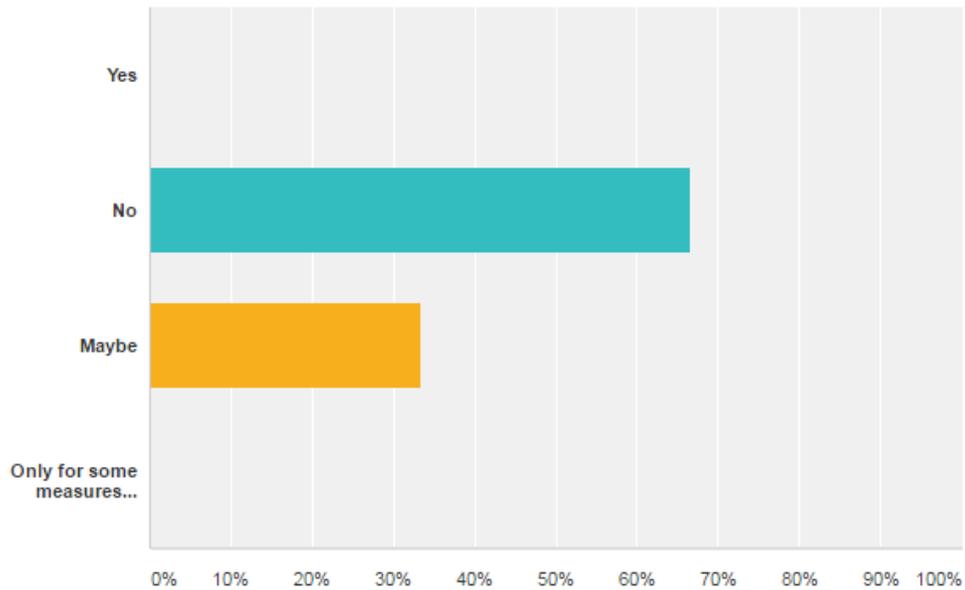
Answered: 3 Skipped: 0



Customers were not willing to pay any, or only a small amount, of the cost to install measures. The two participants that installed ceiling insulation were not willing to pay any incremental cost. The one participant that installed lighting measures (linear T8 fluorescent lighting) was willing to pay approximately one-quarter of the cost.

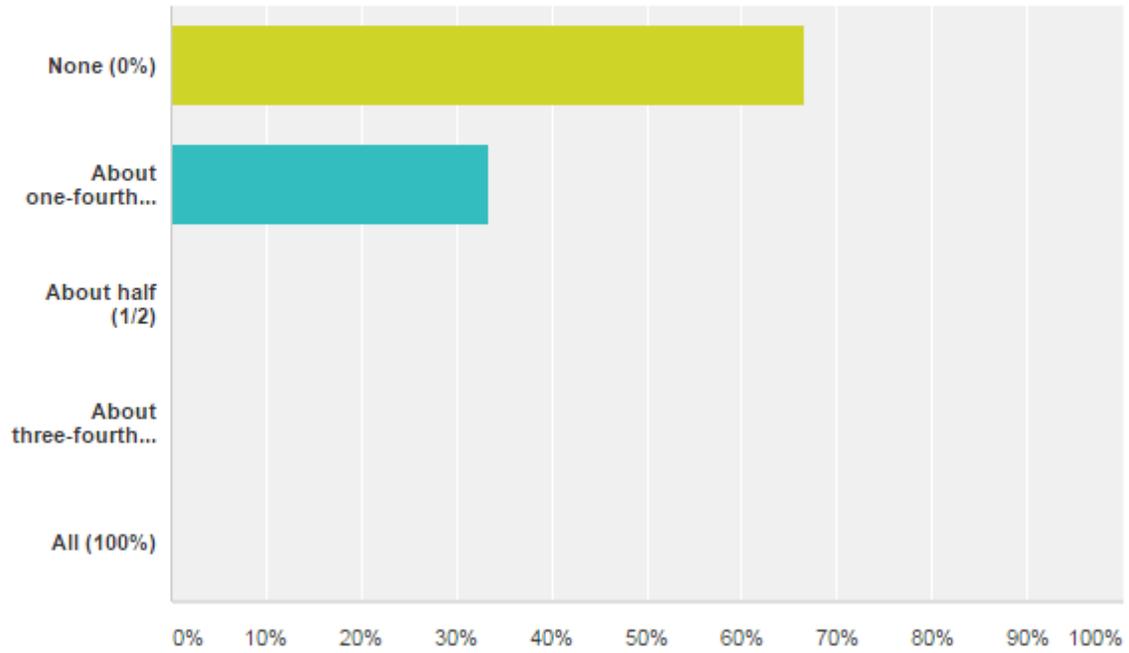
Would you have installed these energy savings measures if the program required that you pay a portion of the cost for the equipment?

Answered: 3 Skipped: 0



What portion would you be willing to pay?

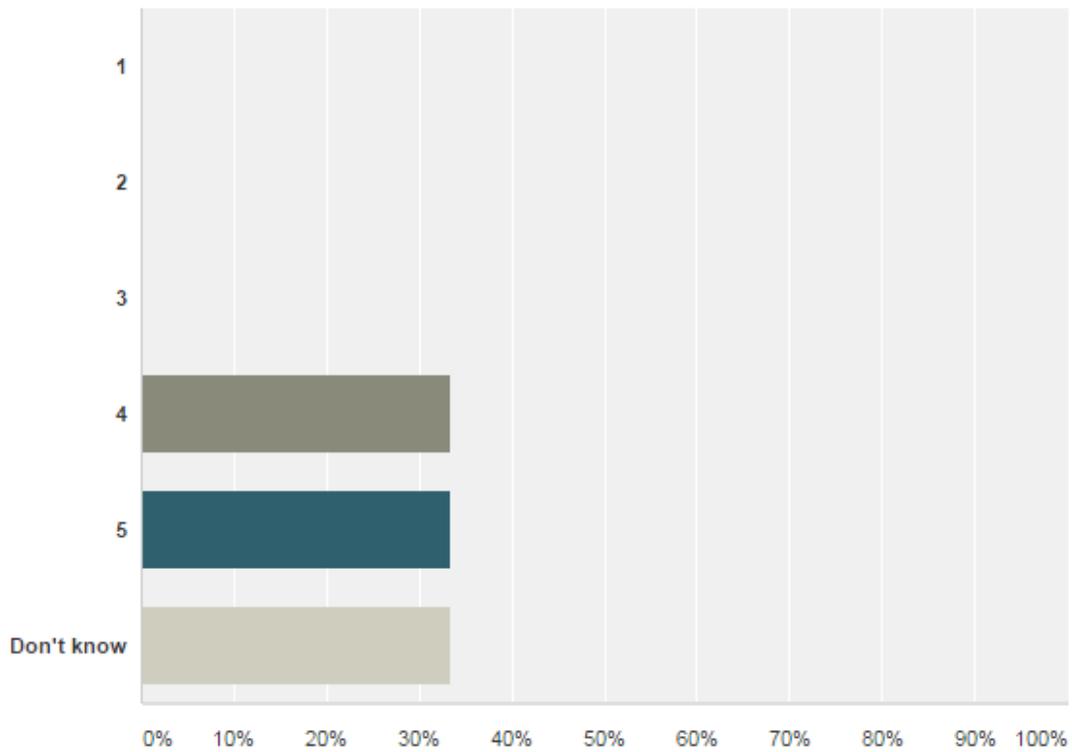
Answered: 3 Skipped: 0



Respondents reported moderate to high satisfaction with the measures and with the program, and would be willing to participate again or recommend it to a peer. The average satisfaction rating was 4 (on a 5-point scale). Participants reported they would be likely to participate again (average ranking of 4.7 on a 5-point scale) and they would recommend it to another property manager (average rank of 4.7 on a 5-point scale).

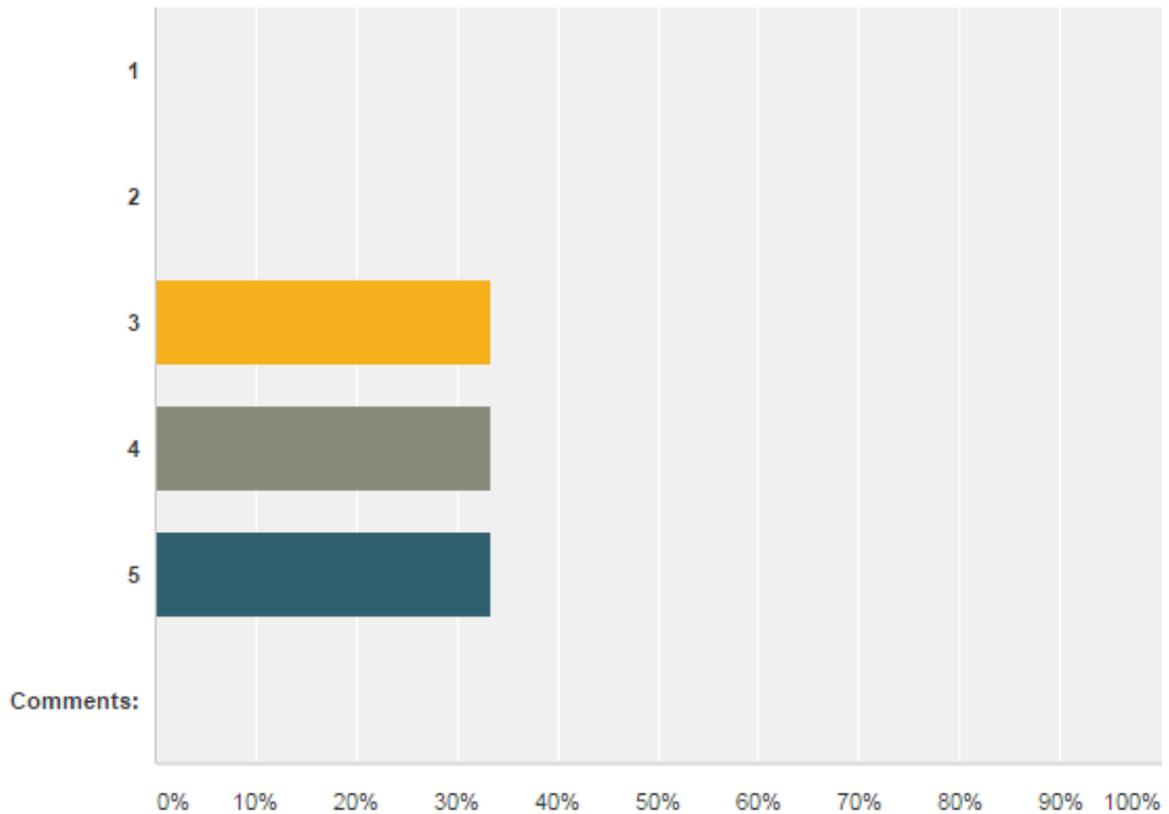
On a scale of 1 to 5, with 1 being very unsatisfied and 5 being very satisfied, how satisfied were you with the energy savings measures installed through the program?

Answered: 3 Skipped: 0



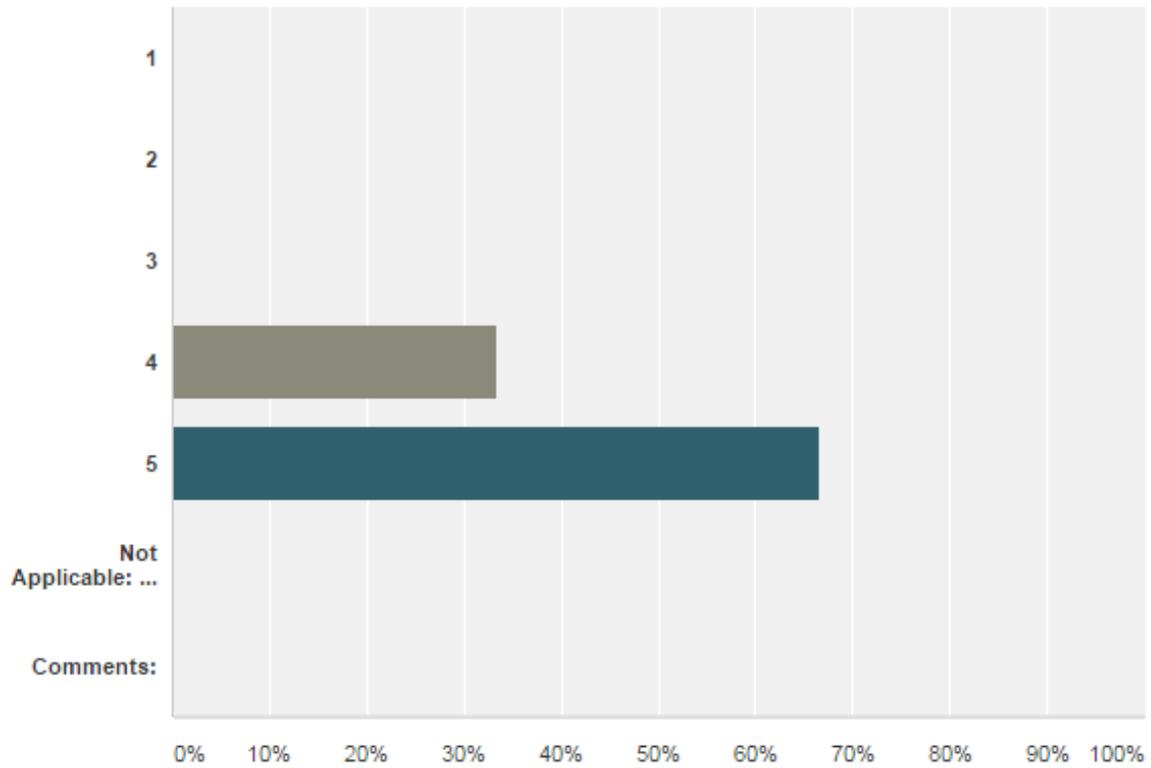
On a scale of 1 to 5, with 1 being very unsatisfied and 5 being very satisfied, please rate your overall satisfaction with the program.

Answered: 3 Skipped: 0



On a scale of 1 to 5, with 1 being very unlikely and 5 being very likely, how likely would you be to participate in the program with another building?

Answered: 3 Skipped: 0



On a scale of 1 to 5, with 1 being very unlikely and 5 being very likely, how likely would you be to recommend this program to other multifamily property owners or managers?

Answered: 3 Skipped: 0

